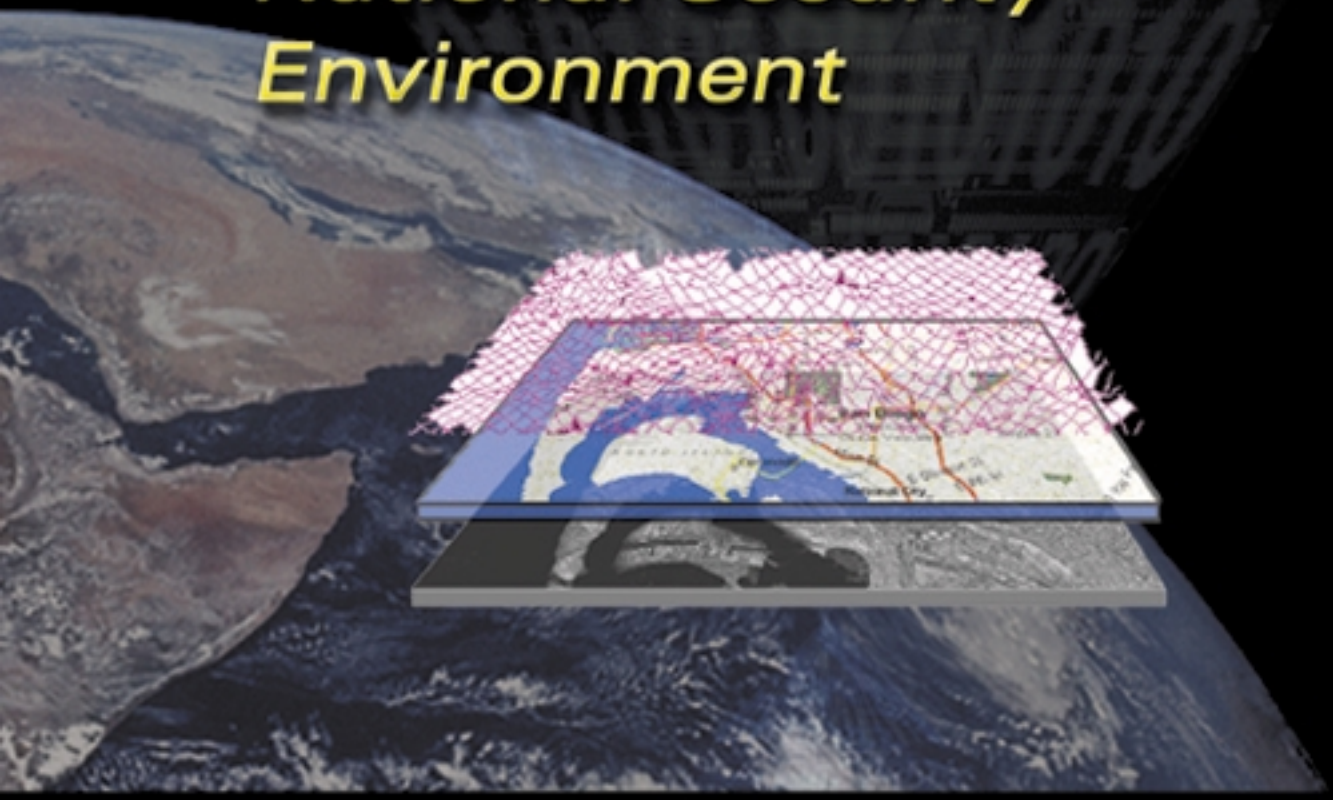
The Information Edge:

Imagery Intelligence and Geospatial Information in an Evolving National Security Environment



Report of the Independent Commission on the National Imagery and Mapping Agency

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Foreword

Last year, the Congress requested that an independent commission be formed to review the National Imagery and Mapping Agency, or NIMA. This report documents the commission's finding and recommendations, some of which need to be addressed by the defense and intelligence leadership, and others by NIMA.

This is a commission of which I am proud. For almost ten months, our nine commissioners, richly experienced and with a set of diverse perspectives drawn from government and industry, worked hard to understand NIMA, including its management and organizations, technology development and acquisition strategies, and its business practices. They focused intensely on NIMA's large and diverse customer base, to understand where NIMA is performing well and where it might perform better. Finally, the commission endeavored to analyze and understand NIMA's future, whether to critically assess the current vision, or to suggest other paths that might be more wisely taken.

We had the benefit of considerable input along the way. Thousands of written documents, hours of briefings, and the attention of many senior Department of Defense and Intelligence Community officials provided candid inputs for our consideration. A diverse set of industry participants gave us a look at current technology and management practices and how NIMA might take advantage of these to best do their mission. Various Commissioners visited Denver, St. Louis, Tampa, and Omaha, and to NIMA representatives supporting U.S. forces in the United Kingdom, Germany, and Italy.

This Commission represents the most recent inquiry into NIMA, one which followed a Defense Science Board study covering many of the same topics. The Commission tried to build on previous studies and where appropriate expand on some of the ideas.

NIMA's mission is complex and daunting. Strong leadership support from both Intelligence and Defense as well as timely implementation of the enclosed recommendations is essential if NIMA is to meet the needs of the national security community in the coming years.

Peter Marino
Chairman

Executive Summary and Key Judgments

Late in the fall of 1999, Congress requested the Director of Central Intelligence (DCI) and the Secretary of Defense (SECDEF) to form a Commission to review the National Imagery and Mapping Agency (NIMA), a new agency perceived by some to be struggling toward coherency as the national security environment and US doctrine—*e.g.*, *Joint Vision 2010*—evolved mercilessly around it. A proximal event was the disappointing realization that design and acquisition of the Future Imagery Architecture (FIA) had sorely neglected the value-adding systems and processes known collectively as "TPED"—the tasking, processing, exploitation and dissemination of the imagery collected by reconnaissance satellites.

The Commission, formed early in 2000 to review key dimensions of strategy and performance of NIMA, has completed its work and offers a number of conclusions and a few recommendations. Several supporting studies were performed by RAND and will be made available in their entirety to the Director of NIMA. The Commission also had the benefit of a number of prior studies, including one recently published by the Defense Science Board. Few of the issues that arose in the course of the investigation were unexpected; most had been previewed by the earlier reports.

The Commission validates the charge that the Intelligence Community is "collection centric," thinking first of developing and operating sophisticated technical collection systems such as reconnaissance satellites, and only as an afterthought preparing to properly task the systems and to process, exploit, and disseminate the collected products.

The Commission concludes that, although some progress has been made, the promise of converging mapping with imagery exploitation into a unified geospatial information service is yet to be realized, and NIMA continues to experience "legacy" problems, both in systems and in staff. Admittedly, these problems are not of NIMA's making—it inherited two disparate cultures, an expanding mission, and inadequate resources. Notwithstanding, the Commission believes that timely development of a robust geospatial information "system" (GIS) is critical to achieving national security objectives in the 21st century. The Director of

NIMA understands this and the Commission has every expectation that he will fulfill the promise, circumstances permitting.

The Commission observes the traditional short tenure of senior-most leadership among Combat Support Agencies and is concerned that, with a nominal tour length of two to three years, the current vision and momentum may not endure sufficiently to become institutionalized. The senior-most NIMA leadership garners high marks, but some NIMA management strata are of uneven quality.

The Commission finds NIMA attempting to modernize all systems simultaneously—anticipating the FIA—with high-caliber systems engineering and acquisition personnel in dangerously short supply both in NIMA and in the Intelligence Community at large, which is simultaneously trying to modernize signals intelligence (SIGINT) and bring next-generation reconnaissance satellites online.

The Commission questions whether US military doctrine has evolved to so rely on intelligence—imagery, especially—that it may become unsupportable with current investments. The need to precisely engage—with strategic considerations—any and every tactical target, without collateral damage, without risk to American lives, requires exquisite knowledge immediately prior to, and immediately subsequent to, any strike. Demonstrably, US imagery intelligence cannot support this activity on any meaningful scale without precarious neglect of essential, longer-range issues without additional resources.

The Commission noted occasional competition for intelligence resources between the Department of Defense (DOD) and non-DOD users of intelligence that borders on the unhealthy. Positive leadership must be exerted jointly and sincerely by SECDEF, the Joint Chiefs, and the DCI, who must first reconcile any differences between and among themselves. NIMA, itself, must be more attuned to impending imbalances.

The Commission learned that in a comprehensive requirements review that helped define FIA, considerable imaging requirements were allocated to commercial and airborne imagery: In peacetime, less than 50% of required area coverage is allocated to FIA, while commercial

and airborne assets accounted for the majority of peacetime area allocations. For peacetime point coverage the reverse is true, with the bulk of peacetime point targets allocated to FIA, and a minority to airborne and commercial assets. During a major theater conflict, about half of both area and point coverage, are allocated to FIA, while commercial and airborne assets combine to meet the other half of all requirements.

FIA holds to the claim that it will meet all its allocations; however, because of negligible budgeting to date for commercial imagery, and proposed reductions in airborne investment, OPSTEMPO and PERSTEMPO—the FIA era still might not live up to its billing as eliminating collection scarcity. Compounding the problem, the Commission could find no credible plans—*i.e.*, adequately funded program—to integrate commercial and airborne products into FIA and/or TPED.

The Commission echoes the sentiments of Congress with respect to the halting way in which the Intelligence Community is embracing commercial imagery collection—processing and exploitation, as well. In retrospect, inadequate notice was taken of the potential availability of high-quality commercial imagery as a part of the larger FIA architecture. In the spirit of Presidential Decision Directive (PDD) 23, the Commission is inclined to endorse the US-industry move to resolutions of 0.5 meters, the capabilities of which should be fully and aggressively incorporated into a serious plan that would, *inter alia,* remove the current fiscal disincentives that discourage end-users from opting for commercial imagery when it can otherwise meet their needs.

The Commission applauds NIMA's outsourcing of products—largely cartographic, to date—and agrees that considerably more may be warranted, including value-added geospatial products, selected imagery analysis products, and specialized, "science-based" imagery exploitation. Indeed, the Commission wonders whether the time may be right to consider externalizing the operation of almost all legacy systems and legacy products, consistent with assured continuity of service and provision for crisis capacity. The benefits would include freeing up scarce-skilled US government (USG) personnel and relief from the strain on the management attention span of NIMA and the Intelligence Community.

The Commission asked hard questions about key aspects of imagery-TPED. Is the design for TPED adequately understood? Is new thinking being incorporated aggressively and balanced with sound management of technical risk? Are users' future needs well enough understood and provided for? Does the TPED design accelerate the integration of imagery and geospatial concepts—the promise, after all, of creating NIMA? Is the TPED approach grounded in modern information systems thinking? And, is there a plan for rapid insertion of new technology? Is NIMA, with its current staffing, capable of managing the acquisition of TPED? Is the likely cost of TPED fully reflected in current budgets? The Commission acknowledges the herculean task of modernizing while under resourced and simultaneously attempting to satisfy the increasing demand for its staple products.

The Commission found reason to be concerned about the level of research and development conducted by and on behalf of NIMA. Imagery and geospatial activities in the national security sector are only partially congruent with those of interest to the commercial information technology sector. The Commission is convinced that woefully inadequate R&D holds hostage the future success of TPED, the US Imagery and Geospatial Service (USIGS), and indeed of US information superiority. Nor does the Commission see sufficient, aggressive, and effective regard by NIMA for the issues of technology insertion.

The Commission feels that US loss of satellite imagery exclusivity makes a robust imagery-TPED absolutely critical, but does not see this urgency reflected in the programming and budgeting for TPED. By way of explanation or excuse, critics have recited their litany of NIMA-TPED ills. While the Commission agrees with some of the criticisms, it fails to see how that situation can be improved by under funding.

Finally, the Commission suggests that the US loss of satellite imagery exclusivity places a hefty premium on SIGINT-IMINT convergence—sooner rather than later—but questions whether the "multi-INT TPED" is being given adequate priority. The Commission cautions, however, that actually integrating Imagery- and SIGINT-TPED is a bigger, more costly, more demanding job than the sum of the two respective pieces done separately. Staffing such an enterprise in a traditional government way seems, to the Commission, to be a nearly insuperable hurdle.

The Commission offers a number of recommendations of which the most global and far-reaching are summarized here. Where possible the recommendations suggest that specific actions, with specific outcomes and set time frames, be assigned to particular officials.

The Commission recommends that the DCI and SECDEF, with such help from Congress as may be required, ensure that the Director of the National Imagery and Mapping Agency (D/NIMA) serve a term of not less than five years, absent cause for dismissal, and subject to the personal needs of the individual. In the event that an active duty military officer serves as Director, the cognizant military service must commit to this length of tour and Congress should ameliorate any unique hardship that this entails upon the military service.

The Commission recommends creation in NIMA of an Extraordinary Program Office (EPO) armed with special authorities of the Director of Central Intelligence and the Secretary of Defense, augmented by Congress and staffed—free of staff ceilings and pay caps—through an heroic partnership between industry, NIMA, and the National Reconnaissance Office (NRO). The EPO, to be constituted from the best national talent, shall be charged with, and resourced for all pre-acquisition activities, systems engineering and architecture, and acquisition of TPED—from end-to-end, from "national" to "tactical." The first milestone shall be completion of a comprehensive, understandable, modern-day "architecture" for TPED. Other provisions of law notwithstanding, the Congress shall empower the Director of the EPO to commingle any and all funds duly authorized and appropriated for the purpose of the "TPED enterprise," as defined jointly by the Secretary of Defense and the Director of Central Intelligence.

With some trepidation—anxious not to delay further NIMA's TPED program—the Commission suggests concomitant study of the evolving TPED strategies on the part of commercial imagery vendors and value-added GIS providers. While the timing may not be right, the opportunity to converge on what may become the commercial mainstream should not be overlooked.

The Director of NIMA—with the Defense Information Systems Agency (DISA) and the managements of Intelink and OSIS—shall ensure promptly that commercial imagery and value-added suppliers are able to pursue an "e-business" model for their products. Budget

submissions for the National Foreign Intelligence Program (NFIP), Joint Military Intelligence Program (JMIP) and Tactical Intelligence and Related Activities (TIARA) budget submissions should realistically reflect needed resources for an aggressive program of "open source" imagery acquisition, which shall be sufficiently robust, stable, and predictable as to encourage US commercial interests. The Secretary of Defense should establish a central source of funds against which components can charge commercial imagery purchases.

The Commission recommends that the DCI and Assistant Secretary of Defense for Command, Control, and Communications (ASD[C3I]) request, and the Congress approve, a substantial increase in research and development by and on behalf of NIMA—in aggregate, an amount more in keeping with the proportionality of cutting-edge industries in the information business. And, to take advantage of this sponsored research, as well as to reap the benefits of the commercial information technology revolution—which fortunately shows no signs of abating—the Director of NIMA shall implement a vigorous technology insertion process. Receptivity to technology insertion should be reinforced in the NIMA workforce and become an incentivized Key Performance Parameter (KPP) of all USIGS system acquisitions; test-beds and Advanced (Concept) Technology Demonstrations (ATD/ACTD) should be used more widely. Consideration should be given to naming a Chief Technology Officer.

Finally, and more broadly, the Commission suggests that serious, far-reaching review is required of evolving US military doctrine and its dependence on an ever-expanding definition of information superiority, so as to determine the contingent liabilities placed on intelligence. These and these alone must define the needed level of investment in intelligence resources by the military services. Anything less is reckless and irresponsible. We cannot simply design intelligence capabilities to cost; we must design-to-cost the overall strategy which consumes intelligence.

Findings of the Commission

NIMA is an essential component of US national security and a key to information dominance. Despite some shortcomings it is a vital, if under-appreciated, organization staffed with talented individuals and led by dedicated officers.

Despite its acknowledged criticality to information dominance, NIMA is under-resourced overall, not only for TPED acquisition (USIGS modernization), but also for commercial imagery procurement, R&D, and training for its officers and for the larger imagery and geospatial community.

NIMA works hard at understanding its customers and, by and large, is quite successful at it. In the field, NIMA receives praise up and down the line. Washington-area customers, too, compliment NIMA but evince concerns about the future insofar as today's relatively happy state of affairs is based on personal relationships and long-term expertise; the concern is that as the present cohort retires the situation could deteriorate.

The tension between the "strategic" (long-term) challenges and the "operational" (short-term) challenges is a larger national security community problem. It most definitely is not the fault of NIMA, despite perceptions of some all-source analysts and their managers that NIMA tilts toward operational military needs at their expense. In fact, the tension itself is more properly characterized as one of balancing long term and short-term intelligence support to a wide range of customers.

D/NIMA appreciates the need to bolster long-term imagery analysis and plans to transfer 300 NIMA positions (60 per year, 2001-2005) from cartography to imagery analysis, all of whom would remain in the Washington, DC, area to support Washington customers and rebuild NIMA's long-term analysis capability.

Having DCI versus the SECDEF as the ultimate tasking authority, in the absence of major hostilities, still makes sense; it continues to ensure that the delicate balance between military and diplomatic intelligence needs is maintained in the face of everyday contentions for national imagery collection resources. The principles of DCI tasking authority, and provision for its transfer to the Secretary of Defense in time of war, have served the nation well. The DCI is purposefully positioned to appreciate national, military, and civil claims against a scarce imagery resource and to adjudicate otherwise irreconcilable contentions as may arise among the constituencies. His role here is not accidental, but by design.

The relatively new positions of Assistant Director of Central Intelligence for Analysis and Production, and for Collection (ADCI/AP and ADCI/C) could benefit NIMA considerably

by prioritizing the information needs of the national consumers and the reflection of those needs on the collection disciplines, especially imagery. They chair Intelligence Community fora for achieving consensus, the National Intelligence Production Board (NIPB), and the National Intelligence Collection Board (NICB), respectively.

"TPED"[1] is critical for sustaining US information dominance, but there are doubts that the design for TPED is adequately articulated or understood; that the incorporation of new thinking is pursued aggressively yet balanced with sound management of technical risk; that users' future needs are well understood and provided for; or that the TPED design accelerates the integration of imagery and geospatial concepts—the promise, after all, of creating NIMA.

Continuing to organize its business model around legacy products and processes puts NIMA at risk in the FIA era, shortchanges the needs and priorities of users, and fails to facilitate convergence of imagery analysis and geospatial production.

Multi-INT TPED is vital to retaining US information dominance, but progress on converging even IMINT and SIGINT is halting at best. The recent announcement about cooperation on shared requirements databases is a step in the right direction. Against all odds, there is compelling evidence that NIMA should be in the forefront of this convergence because it owns the geospatial construct.

There is a justifiable lack of confidence in NIMA's current ability to successfully accomplish its acquisition of TPED (by whatever name)—reminiscent of the lack of systems engineering and acquisition capabilities of its forebears. The current TPED (or, USIGS modernization) acquisition effort lacks a clear baseline, which should tie closely to overall strategy, requirements, and cost constraints. Heroic measures will be required to remedy the problems. D/NIMA could well benefit from an advisory panel to help, in the first instance, with TPED acquisition.

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[1] Here we mean to include both imagery and geospatial "TPEDs". When necessary, the term "imagery TPED" is used. Generally, TPED and USIGS can be relatively interchangeable. The reader is referred to the discussion of what TPED is and what USIGS is.

There is accumulating evidence that the likely cost of TPED (or USIGS modernization) is not accurately reflected—*i.e.*, is significantly underestimated—in the current POM/IPOM. Supporters and detractors alike recognize that the NIMA infrastructure is not up to the present mission, much less the future, and that the full value of FIA cannot be realized unless major improvements are made.

The lines of responsibility between TPED and communications systems, both terrestrial and space, have been blurred. The dialogue so far among NIMA, DISA, NRO, and the user community engenders no confidence that the links will be there when needed. The CINCs and Services conveniently profess not to know where TPED ends.

D/NIMA's position is very difficult—he tries to serve two masters, tries to harness two cultures, is under-resourced, driven by technology, and he is forced to run the organization at the tactical as well as strategic level because of uneven management strength in some of his direct reports. The middle management corps is the key to NIMA success in merging cultures, in modernizing, and in outsourcing.

The current tour length of the Director of NIMA, two to three years, is too short to solidify accomplishments, institutionalize solutions, and sustain the momentum for needed change; it allows the Director's intent to be frustrated by recidivists who wait out the change in leadership.

The FIA requirements process expressed considerable demand for commercial imagery, and there is considerable additional latent demand in the field, both of which are seriously attenuated by the fact that national technical means (NTM) appears to be a free good, while buying commercial imagery means trading off against beans and boots and bullets. NIMA's commercial imagery strategy is lackluster and the larger US strategy to commercialize remote sensing is as yet unrealized due largely to the Intelligence Community's and DOD's reticence.

While the US has not been aggressive enough in approving commercial imagery licenses, the National Security Council (NSC) is to be applauded on its recent decision to approve a 0.5-meter commercial imagery license.

There is evidence of cultural and bureaucratic impediments to outsourcing NIMA products, but there are some in NIMA intent on getting the in-house/outsourced balance correct. Lacking, however, is a well-thought-out overall strategy for what might be called "transformational" outsourcing *vice* using contractors as a "body shop" supplement to a government workforce.

Not yet taking maximum advantage of commercial hardware and software, NIMA appears to depend heavily upon existing processes and products and persists in developing government standards that diverge from emerging commercial standards. Nor is NIMA properly positioned to make good use of an e-business model, which would allow for online order taking and order fulfillment, peer-to-peer and business-to-business transactions, and "point-of-sale" financial transactions.

The documented decline in experience and expertise in its imagery analyst corps jeopardizes NIMA's ability to support its customers. Not limited to NIMA, the downturn in analytical expertise is due to both loss of experienced people and the fewer number of years of experience held by the new hires.

SES/SIS positions in NIMA hover around 1 percent; this is puny, even in comparison to the USG average of 2.5 percent and quite a bit lower than sister intelligence agencies.

Inheriting no R&D legacy from its predecessor organizations, NIMA, today, has too little R&D investment and no overall strategy; it could benefit from a Chief Technology Officer. NIMA is not well positioned for rapid and continual technology insertion and does not make use of Advanced Concept Technology Demonstrations (ACTD).

When NIMA does choose to rely on contractors, its acquisition and contracting practices come in for heavy criticism even from successful bidders. If NIMA is to take full advantage of commercial offerings, it must be seen as a steadfast partner.

The sooner NIMA forsakes legacy products in favor of data sets from which the products—legacy and new—can be constructed by consumers downstream, the better.

D/NIMA does not fully assert his role as functional imagery manager, has too little say over end-to-end architecture (including the "last tactical mile"), and too little leverage over *all* intelligence and defense imagery-related investment.

1. Introduction

NIMA's history has been brief, but the Agency has been scrutinized repeatedly by Inspectors General, Defense Science Board Task Forces, and congressional fact finders, *inter alia.* With all the best intentions, the oversight has been time-consuming and each successive review has rediscovered the blindingly obvious. This is not to say that each did not add value to the work of its predecessors, but only to point out the law of diminishing returns.

The Director of NIMA was extremely helpful to the present NIMA Commission. Not in so many words, but D/NIMA did let on that he hoped this NIMA Commission would become known, not only as a fount of insights but also as "The *Last* NIMA Commission," at least for a while.

1.1 Commission Creation

The Classified Annex to the FY 2000 Department of Defense Appropriations Conference Bill established an independent Commission to review the National Imagery and Mapping Agency (NIMA). The Secretary of Defense (SECDEF) and the Director of Central Intelligence (DCI), through the Assistant Secretary of Command, Control, Communications, and Intelligence (ASD[C3I]) and the Deputy Director of Central Intelligence for Community Management (DDCI/CM), respectively, appointed members to the Commission. RAND's National Defense Research Institute—a federally funded research and development center (FFRDC)—was chosen to provide the Executive Secretary and other staff for the Commission.

The Commission's charge was to look broadly at NIMA, across the spectrum of management, system development and acquisition, imagery and communications technologies, and organizational development.

1.2 Specific Commission Tasks

The Commission was charged to conduct a comprehensive review of NIMA's present organizational and management structures, current technology development and acquisition

plans, business practices, and operational support services provided to the Defense Department and the Intelligence Community. The review was to include, but not be limited to, the following issues and questions:

- ✓ A review of the management challenges at NIMA;
- ✓ The most effective future course for NIMA's strategic technology development and acquisition programs;
- ✓ The prospect and the efficacy of greater use of commercial sources for imagery collection and exploitation, geospatial information, and storage and retrieval of data and information;
- ✓ The efficiency of NIMA business practices;
- ✓ An assessment of acquisition experience and system integration experience of the NIMA workforce;
- ✓ The sufficiency of current requirements forecasts and cost estimates for USIGS (the US Imagery and Geospatial Service(s)/System) to include an assessment of the adequacy of the budgetary resources devoted to USIGS over the current five-year defense plan (FYDP); and,
- ✓ An investigation of a nettlesome issue generally referred to as "national versus tactical," which the Commission found to be a misnomer.

1.3 Makeup of the Commission

Peter Marino, **Chairman**

Nancy E. Bone, **Commissioner**

Jack Dangermond, **Commissioner**

R. Evans Hineman, **Commissioner**

James V. Hirsch, **Commissioner**

Robert King, **Commissioner**

C. Lawrence Meador, **Commissioner**

Keith Rhodes, **Commissioner**

LTG Sidney ("Tom") Weinstein, (USA ret),
Commissioner

Kevin O'Connell, **Executive Secretary**

Dr. Joseph Markowitz, **Senior Consultant**

Steve Comer, **CMS Liaison**

Capt. Steve Monson, USN, **C3I Liaison**

Rahul Gupta, **Commission Staff**

Dana Johnson, **Commission Staff**

Charles Kelley, **Commission Staff**

Martin Libicki, **Commission Staff**

Julie Jones, **Executive Officer**

John Ivicic, **Security Officer**

1.4 Commission Methodology

As might be expected, the Commission met frequently in plenary sessions where it heard briefings from current and former Executive Branch officials from defense and intelligence organizations, congressional staff present at the creation of NIMA, and representatives from the commercial sector. The majority of the information was gleaned from NIMA officers, who were exceptionally responsive, and from NIMA's customers—military and non-military, operational and intelligence organizations, and other civil (non-defense) organizations—who all were unsparing of their time to help the Commission in its work.

In the course of its deliberations, the Commission journeyed beyond Washington as and when necessary, most often to meet with NIMA's consumers on their home ground and to visit commercial and industrial partners.

The Commission, as commissions often do, found it useful to organize itself into working groups for the purposes of digging deeper into particular issues and making most efficient use of the diverse expertise represented on the Commission. The working groups were

> **TPED Working Group—**reviewed the logic of TPED, its current state, and its acquisition management. Its first challenge was defining TPED—or USIGS modernization—and understanding its scope. Another challenge was to understand whether the program to replace IDEX-II imagery workstations had run aground, and if so, why. An emphasis on architecture and multi-INT issues rounded out its program.

Management Working Group—considered, *inter alia,* the respective roles of the DCI and SECDEF, the authorities and responsibilities of the Director of NIMA, and a variety of workforce issues.

Commercial Working Group—focused on the entire spectrum of "commercial" issues:

- ✓ Commercial Imagery—its potential economies and ability to unburden USG collection systems, as well as its potential both to contribute to US information superiority and to diminish US information superiority;
- ✓ Commercial Sources—the issues that surround outsourcing of products and services;
- ✓ COTS—the degree to which NIMA can take advantage of commercial "off-the-shelf" technology in its systems; and,
- ✓ "Commercialization"—the change in business processes that might embrace ***e***-commerce practices and allow those who consume the imagery capacity to be better informed as to the cost of the resources they consume—*i.e.*, turn the "consumers" into "customers."

Clean Sheet Working Group—spawned a "Clean Sheet Working Group" to investigate what NIMA would look like if reinvented free from its legacy information systems. The Working Group chose to focus on NIMA's information architecture largely because of the business that NIMA is in. But there was an important secondary reason. NIMA is about to embark on a major TPED acquisition initiative, which will, for better or worse, define its information architecture for a decade or two to come.

1.5 A Review of Previous Studies of NIMA

There have been a number of insightful studies of NIMA, of which the Commission took full advantage. At least nine studies of NIMA, some classified, some not, have been

conducted in the last few years. Some of these studies had a very specific focus, while others took a broader review of NIMA, as has this Commission.

The preparation of this report prompted us to review some of the major themes that emerged in those efforts and how they relate to our own. **Virtually every one of these studies envision NIMA as a smaller, elite, and mission-driven organization in the future. They also envision an important role for NIMA in US information dominance, derived both from imagery and geospatial information.** Prominent among the earlier studies and again addressed here are the following themes:

- The need to strengthen NIMA's role as the functional manager for imagery and geospatial information

- The need to develop NIMA's workforce, especially in the areas of systems engineering, acquisition, and imagery analysis

- The need for better planning and communication with regard to tasking, processing, exploitation, and dissemination (TPED)

- The need to take strong advantage of an emerging commercial sector, and focus government resources on providing unique capabilities

- NIMA's challenges in technology planning and acquisition, especially in the area of TPED, and

- The need for agile, integrated tasking and other capabilities across satellite, airborne, and commercial sources of imagery.

The Commission has two observations related to these recommendations and the challenges inherent in them:

First, while NIMA's transformation is still incomplete, and progress against some of the goals mixed, the Commission observes progress in virtually every area. For example, while the Commission has a number of comments and recommendations about NIMA's acquisition and technology issues, we do find demonstrable progress across the period of these studies in the NIMA Acquisition and Technology Directorate. Second, and in light of our own recommendations, the Commission suggests that it is time to let NIMA get on with implementing the recommendations made by this and prior panels. The continued study of NIMA drains resources from those staff who must interact with task forces, and from those who must implement what is an increasingly clear set of issues required for NIMA's transition to a more effective agency.

1.6 Support to the Commission

The Commission had the full support of the Community Management Staff (CMS)—including the personal help of the Hon. Ms. Joan Dempsey, the Hon. James Simon, and the ASD(C3I)—again, including the personal support of the Hon. Art Money, and Capt. Steve Monson, USN.

NIMA itself provided immeasurable support, starting with the personal attention of General King, Director of NIMA, without whom the report would not be the same. His staff and management team were equally unstinting in their support.

The Commission was ably aided by RAND's National Defense Research Institute, which studiously recorded critical items of information from the briefings and researched special topics for the Commissioners. The special studies included:

Commercial Imagery Policy: This study assessed the overall state of progress within the United States on imagery commercialization, including an assessment of input factors to the second-generation licenses under National Security Council consideration during the Commission's tenure. The study analyzed NIMA's Commercial Imagery Strategy in light of this situation, and made recommendations about its future course.

"National Versus Tactical" Issues: This classified study assessed the US imagery collection strategy in an area of high contention for collection resources, in order to understand whether there is an imbalance between strategic targets and tactical targets. This study also included a number of analytic experiments designed to look at how changes in collection strategy–such as changes in collection priority, platform, or sensor–-would impact overall collection volume as well as collection against strategic and tactical targets in the given area.

Outsourcing: This study looked at NIMA's strategic vision and the role of outsourcing within it. It assessed the tensions between NIMA's attempts to modernize (partially) through outsourcing and more traditional perspectives on production both at NIMA and within the NIMA customer base. It mapped the role of outsourcing–and the mechanisms to implement it–from NIMA's strategic plan and business plans through its outsourcing strategy and outsourcing processes. The study also analyzed the effectiveness of NIMA's outsourcing processes in the areas of mission support and geospatial products, including the "make-or-buy" decisions associated with them.

TPED Acquisition: This study examined the acquisition strategies being used by NIMA to acquire the hardware, software, and other equipment needed to support the agency's role in tasking, processing, exploitation, and dissemination (TPED). It looked at the dominant characteristics of NIMA acquisitions–such as the emphasis on commercial-off-the-shelf (COTS) technology, use of open architecture, and the level of integration challenge–the dependent factors for NIMA's acquisition strategy, and an assessment of three systems that NIMA is presently acquiring in light of those factors.

RAND also provided tailored support to the Commission's Working Groups. Among the inputs to the Commission were papers and briefings on the following topics:

"Clean Sheet" Paper: RAND coordinated the various inputs of the Clean Sheet Working Group into a document, entitled "An Alternative Scenario for NIMA: Strategy, Structure, Process, and Technology." Portions of this paper have been incorporated directly into this report.

Briefing on Organizational Cultures: This briefing for the Management Working Group identified the key internal and external factors influencing NIMA's emerging organizational culture, including the extent to which NIMA's component cultures–military, mapping, and intelligence–create challenges for current attempts to merge imagery and geospatial analysis. The study postulates three alternative futures for NIMA, including the culture/capabilities mix implications for each of them.

Paper on Geospatial Technologies: This paper, entitled, "The Integration of Geospatial Technology and Information into Our Everyday Lives," identified current trends in geographic information systems and other geospatial technologies, and a future vision of the geospatial marketplace. It identified the changing role of user communities, data issues, and standards as important elements of that marketplace. The NIMA Commission's Commercial Working Group was a co-sponsor of this paper, along with another RAND sponsor.

Copies of these RAND studies will be made available to the Director of NIMA. A complete list, for the record, of those individuals and organizations with whom the Commission met is available in the appendix of this document.

2. NIMA from the Beginning

The National Imagery and Mapping Agency (NIMA), according to its own lights, "…was established October 1, 1996, to address the expanding requirements in the areas of imagery, imagery intelligence, and geospatial information. It is a Department of Defense (DoD) combat support agency that has been assigned an important, additional statutory mission of supporting national-level policymakers and government agencies. NIMA is a member of the Intelligence Community and the single entity upon which the US government now relies to coherently manage the previously separate disciplines of imagery and mapping. By providing customers with ready access to the world's best imagery and geospatial information, NIMA provides critical support for the national decisionmaking process and contributes to the high state of operational readiness of America's military forces."[2]

NIMA was borne, not out of whole cloth, but by combining extant intelligence and defense organizations involved in imagery exploitation and mapping, charting, and geodesy—mainly, the National Photographic Interpretation Center (NPIC) and the Defense Mapping Agency (DMA).[3] The creators, *inter alia,* were the Hon. John White, then Deputy Secretary of Defense, and the Hon. John Deutch, then Director of Central Intelligence. The creation of NIMA presumed a natural convergence of the mapping and image-exploitation functions—as each become "digital"—into a single, coherent organization organized around the construct of a geospatial information system (GIS).

NIMA's creation was clouded by the natural reluctance of two cultures to merge and the fear that their respective missions—mapping in support of defense activities versus intelligence production, principally in support of the national policymaker—would be subordinated, each

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[2] http://164.214.2.59/general/faq.html.

[3] More completely, "NIMA was formed through the consolidation of the following: the Defense Mapping Agency (DMA), the Central Imagery Office (CIO), the Defense Dissemination Program Office (DDPO), and the National Photographic Interpretation Center (NPIC) as well as the imagery exploitation and dissemination elements of the Defense Intelligence Agency (DIA), the National Reconnaissance Office (NRO), the Defense Airborne Reconnaissance Office (DARO), and the Central Intelligence Agency" *ibid.*

to the other. To a large extent, a NIMA culture has yet to form, but the Commission is heartened by signs that the two legacy cultures have begun to see benefit in melding their respective disciplines to solve real intelligence problems, as exemplified in a later section.

While convergence of mapping and imagery exploitation around the organizing GIS construct still appears to make good technical sense, NIMA has yet to achieve unity, either of purpose or personnel. Even in today's new-speak, NIMA advertises itself in terms of USIGS—the US Imagery *and* Geospatial Service. The NIMA mission—to provide timely, relevant and accurate imagery, imagery intelligence, and geospatial information in support of national security objectives—shows the same multiplicity.

This is not to downplay the early challenges of merging multiple administrative, logistic, and personnel systems at different locations, while trying to communicate/collaborate over different, noninteroperable computing and communications systems.

NIMA's vision is to guarantee the "information edge" to the US national security community. Expanding on its vision, NIMA aims to have its information provide the common reference framework for planning, decisions, and action; provide ready access to databases of imagery, imagery intelligence, and geospatial information that it acquires and/or produces; use its information holdings to create tailored, customer-specific solutions, the information from which enables their customers to visualize key aspects of national security problems; and to value the expertise of its people who are critical to acquiring and/or creating the information that gives the advantage to its customers.

Suitably laudable are NIMA's core values: commitment to its customers, demonstrated pride, initiative, commitment, personal integrity, and professionalism; a culture that promotes trust, diversity, personal and professional growth, mutual respect, and open communication; an environment that rewards teamwork, partnerships, risk taking, creativity, leadership, expertise, and adaptability; and a tradition of excellence and personal accountability.

3. NIMA in Context

3.1 The National Security Context

When the Soviet Union exited the world stage left, the US national security community breathed a momentary, collective sigh of relief. The elation was, however, short-lived. Despite the clamor of the popular sentiment for a "peace dividend," the challenges to our national security, perhaps less immediately life threatening, became more numerous, more diverse, and, in some ways, more difficult.

Emerging threats notwithstanding, the United States drew down its military and intelligence capacity as it traditionally had done after resolution of each preceding conflict. The Gulf War was but a satisfying interlude to "demobilization" through which we coasted on our residual military strength and our accrued intelligence. What should have been an object lesson on the wisdom of investing in capability became, instead, the rationale for continued disinvestments because of the lopsidedness of the Gulf conflict.

There were two lessons learned, and subsequently reinforced, one by the policymakers and the public, the other by military planners.

Policymakers and the US public—having seen the vision of miraculously light American casualties and minimal collateral damage—forced "rules of engagement" to become excessively stringent (and overoptimistic). There is wishful endorsement of the kindest, gentlest, "zero-zero" warfare—zero American lives lost, zero collateral damage.

Military planners evolved *Joint Vision 2010* (now *2020*) that placed immense faith in the ability of the intelligence community to deliver on the military desire for continued information superiority, indeed, "dominance".

Consequently, a substantial "contingent liability" was levied on intelligence, at a time when intelligence capabilities were still being diminished apace. The result, to paraphrase a

popular motion picture, is that political and military thinkers are writing checks that the Intelligence Community cannot cash!

In 2020,[4] the nation will face a wide range of interests, opportunities, and challenges. This will require diplomacy that can effectively advance US interests while making war a less-likely last resort, a military that can both win wars and contribute to peace, and an intelligence apparatus that can support both. The global interests and responsibilities of the United States will endure, and there is no indication that threats to those interests and responsibilities, or to our allies, will disappear.

Three aspects of the world of 2020 have significant implications for our statecraft, our Armed Forces, and the Intelligence Community that underpins both. First, the United States will continue to have global interests and be engaged with a variety of regional actors. Transportation, communications, and information technology will continue to evolve and foster expanded economic ties and awareness of international events. Our security and economic interests, as well as our political values, will provide the impetus for engagement with international partners. For the engagement to be successful, no matter the playing field or the opponent's rules, our commercial and diplomatic "forces" must be fully informed and constitutionally prepared to prevail short of war, while our military must be prepared to "win" across the full range of military operations in any part of the world, to operate with multinational forces, and to coordinate military operations, as necessary, with government agencies and international organizations.

Second, potential adversaries will have access to the global commercial industrial base and much of the same technology as the United States. We will not necessarily sustain a wide technological advantage over our adversaries in all areas. Increased availability of commercial satellites, digital communications, and the public Internet all give adversaries new capabilities at a relatively low cost. We should not expect opponents in 2020 to engage with strictly "industrial age" tools—information-age tools will be the key to our effectiveness.

Third, we should expect potential adversaries to adapt as our capabilities evolve. We have superior conventional warfighting capabilities and effective nuclear deterrence today, but this favorable military balance is not static. We have the best intelligence and most fully informed statecraft. In the face of such strong capabilities, the appeal of asymmetric approaches and the focus on the development of niche capabilities by potential adversaries will increase. By developing and using approaches that avoid US strengths and exploit potential vulnerabilities using significantly different methods of operation, adversaries will attempt to create conditions that frustrate our US diplomatic, economic, and military capabilities.

The potential of such asymmetric approaches is perhaps the most serious danger the United States faces in the immediate future—and this danger includes long-range ballistic missiles and other direct threats to US citizens and territory. The asymmetric methods and objectives of an adversary are often far more important than the relative technological imbalance, and the psychological impact of an attack might far outweigh the actual physical damage inflicted. An adversary may pursue an asymmetric advantage on the tactical, operational, or strategic level by identifying key vulnerabilities and devising asymmetric concepts and capabilities to strike or exploit them. To complicate matters, our adversaries may pursue a combination of asymmetries, or the United States may face a number of adversaries who, in combination, create an asymmetric threat. These asymmetric threats are dynamic and subject to change, and the United States must maintain the capabilities necessary to successfully anticipate, deter, defend against, and defeat any adversary who chooses such an approach. To meet the challenges of the strategic environment in 2020, our diplomacy and our military must be able to achieve full spectrum dominance.

3.2 The Collection Context—FIA

The Commission observes that the FIA-era increase in imagery of more than an order of magnitude does not, in and of itself, imply a need for a proportionate increase in exploitation capacity. Some increase may be needed, but an *N*-fold increase in imagery does not

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[4] This section paraphrases and elaborates upon the "Strategic Context" of *Joint Vision 2020.*

necessarily translate into an *N*-fold increase in information content, particularly when the additional imagery capacity is used to more frequently "sample" the same target for activity analysis, or indications and warning (I&W). Watching grass grow does not take a lot of exploitation.

The Commission notes, elsewhere, that there are outstanding requirements, endorsed by the Joint Chiefs of Staff (JCS) and not satisfied by FIA as currently baselined. Among these, military users of imagery, especially the US Army, argue for the importance of direct theater downlink (TDL). Of course, the argument goes beyond just the "downlink" of imagery, which is effectively accomplished with only minimal delay, today, *via* communications satellites. Rather, the argument is, a regional commander should be "apportioned" the space reconnaissance assets as they are in view of his theater of operations. However, National technical means, FIA included, have not been designed, heretofore, to accommodate this requirement. To modify the electro-optical imaging design would substantially reduce the available imaging time over theater as the satellite traded off imaging operations for communications operations.

The Commission notes, in passing, that at least one of the commercial satellites[5] is actually a TDL design. Its tasking instructions and deposit of imagery are done by "regional operations centers" (ROCs), and inasmuch as the commercial vendor is anxious to sell "imaging minutes on orbit" the US military could experiment, today, with this concept, and "pay by the minute"—*i.e.*, without capital investment or long-lead programming and budgeting. Cryptographic provisions to guarantee theater privacy are already in place.

3.3 Commercial Imagery

On September 24, 1999, Space Imaging successfully "launched" the world's first

[5] IKONOS, the newest imaging satellite launched and operated by Space Imaging, Thornton, Colorado.

commercial one-meter imaging satellite, IKONOS. The US government was a positive factor in this endeavor, despite some national security reservations, and Presidential Decision Directive 23 codified US policy on foreign access to remote sensing capabilities. Space Imaging was granted a license that permitted it to sell commercial imagery at a resolution of one meter, among others.

While the importance of resolution is often overstated, improved resolution clearly allows new information to be extracted from an image. As imagery resolution moves from the tens of meters to one meter and below, military applications move beyond terrain analysis, through gross targeting, to precision targeting, bomb damage assessment, order-of-battle assessment, to technical intelligence findings.

The Commission endorses the move to allow US companies to move to higher resolution as required by the competition and demanded by the marketplace. It will demonstrate continued technical superiority and signal US government intent to keep US companies in the forefront. It will raise the bar, discourage others, and impose new barriers to entry. More importantly it will open up new markets for satellite imagery now the exclusive province of airborne photography. And the vastly improved, immediately visible resolution characteristics will substantially improve "eye appeal," capturing the imagination of the public, and especially the imagination of those from whom the new applications will flow. The vitality produced by this change cannot be overstated—this energy will fuel the next generation of NIMA-relevant COTS technology.

Until recently, NIMA has been a captive customer for satellite imagery provided by the National Reconnaissance Office (NRO), whose *raison d'etre* is building and operating satellites, pure and simple. Because of government internal accounting practices (planning, programming, and budgeting) the NRO has a capital budget to build satellites that is loosely derived from requirements that NIMA voices on behalf of its consumers.[6] Once the satellites are built and launched, there is no attempt to recover sunk costs. Even operating costs for the imaging constellation, ground processing, and exploitation are not recovered.

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[6] "Consumers," not "customers," because, as we shall see, they do not "pay" for products in the conventional sense—no unseen hand of Adam Smith operating here!

Imagery acquired from US "National technical means" is a free good.[7] However, use of commercial imagery either by NIMA or by its consumers directly is not a free good; operating budgets must accommodate any imagery purchases from Space Imaging and/or its competitors. In a sense, notes the Commission, commercial imagery providers face competition from an established behemoth with deep pockets that gives away its wares.

The US government, Defense and Intelligence, and/or NIMA have not requested that the Congress appropriate substantial funds for commercial imagery. Notwithstanding, the Congress has successively appropriated "extra" monies for NIMA to purchase commercial imagery (and, presumably, value-added imagery products). The Commission is disappointed that NIMA has been slow to articulate a commercial imagery strategy that Defense and Intelligence would endorse. The Commission is more distressed by an announcement promising $1 billion for commercial imagery purchase, which has subsequently proved to be so much fiction.

[7] But, because it is free and (therefore) heavily oversubscribed, it is rationed by an elaborate, dynamic prioritization scheme that is accused by some of being politicized as well as cumbersome.

4. Two-and-a-Half Roles for NIMA

Below we describe two missions and a supporting function: intelligence production, geospatial information provision, and acquisition agent, respectively. We distinguish between the two missions, each of which NIMA has to do, and acquisition, which could be done for NIMA although the Commission does not endorse distancing acquisition in this way.

The Commission distinguishes the mission of intelligence from that of geospatial information by noting that in the former case, the analyst tries to go beyond the data, while in the latter, the GIS specialist tries to portray the data with scrupulous accuracy.

4.1 NIMA as an Intelligence Producer

NIMA inherits a proud tradition of imagery analysis from its forebears, especially the National Photographic Interpretation Center (NPIC). We can trace the modern era of national imagery collection to the U2, its successor the SR-71, and the earliest film-return satellites. Each was a technical marvel in its own right: the U2, an airplane that could fly so high that no then-available missile or pursuit plane could reach it; the SR-71, an airplane that could fly so fast that none could catch it; and satellites still further out of reach, aloft for years, which ejected exposed film cassettes to be snagged in midair by a plane that would deliver it to the classified "drugstore" to be developed. Equally marvelous was the exploitation industry that grew up to service these reconnaissance assets, especially NPIC—generations of dedicated men and women at light tables continuously developing their art and improving their craft.

The information gleaned from national imagery has informed (and transformed) US policy and operations—it has, indeed, assured the safety of the republic. To successfully "read out" the story an image has to tell requires both technical and substantive experience. Recounting that story in a convincing way to the uninitiated requires additional expository and illustration skills. Not all imagery interpreters/analysts have all skills honed to the same degree. Indeed, one can distinguish between photo interpreters (PIs) and imagery analysts

(IAs), the latter, some would say, being the higher calling. By whatever name, however, IAs and PI's historically have seen themselves as distinct from geographers and cartographers—the stuff of a Geospatial Information Service (GIS). Moreover, the business processes that consume imagery intelligence are distinguishable from those that consume GIS data.

There is absolutely no expectation that NIMA's role as an imagery intelligence producer will decline. If anything, because of the travails of the US SIGINT system—going deaf, some would say—the role of imagery intelligence will be still more important.

4.2 NIMA as a GIS Provider

An equally proud tradition, which NIMA inherited from the Defense Mapping Agency and its predecessors, is the provision of maps and charts to the Defense Department and beyond. The mission of mapping, charting, and geodesy (MC&G) has been, and continues to be, critical to the national security community. NIMA produces over one hundred standard "map" products. These remain in high demand. Indeed, despite the digital revolution, NIMA is distributing more paper products than ever. Notwithstanding, the mission has evolved rapidly, apace with information technology, and now we speak more broadly of a Geographic Information Service/System.

The skills of the geographer and cartographer need to be honed every bit as finely as those of the imagery analyst (IA) or photo interpreter (PI). But, they have not traditionally been fungible. The Commission forecasts the broader construct of GIS will come to embrace both and foster a convergence of skill sets.

Despite some encouraging experiments with collocation of the two disciplines, and encouraging examples such as that recounted below in *Tale of Two Cities*, the Commission has looked largely in vain for real convergence. Interestingly, it found some, not in Washington or St. Louis, but in-theater, closest to military operations, where "topographic engineers" are creating fused products. Both US Army intelligence doctrine as well as US army engineer doctrine should explicitly articulate how the terrain analysts should work with imagery and intelligence analysts throughout the force, as well as how the larger "topo" battalions relate to NIMA.

4.3 The Role of Acquisition in NIMA

NIMA is in the information business. Therefore, NIMA requires information systems to execute its core missions of producing imagery intelligence and providing GIS information. However, the acquisition of those systems need not be considered a core business of NIMA. Another, responsive, organization could well be the procurement agent for NIMA systems. This has a certain appeal.

NIMA's forebears, by and large, did not do systems acquisitions: DMA and NPIC both required (and received) outside help for their major systems procurements. Consequently, NIMA has neither the tradition nor the organic assets to conduct major systems engineering and acquisition activities. It is trying to build such a cadre. However, the going is slow, and the competition for information-systems skills fierce. Moreover, building a cadre of systems engineering and acquisition skills inevitably comes at the expense of the core skills of imagery intelligence and GIS. There is internal competition for slots and grades, and more important for upper-management attention.

The Commission wrestled with the question of how intimate to NIMA must be the systems acquisition and acquisition activities. The Commission sought external alternatives but found none satisfactory—none skilled with the "excess" capacity to take on the NIMA workload. Grudgingly, the Commission concludes that NIMA must, itself, acquire the skills to acquire. However, the Commission recommends that NIMA do this in a manner highly unusual for government, and the reader is directed to those sections of the report that discuss and recommend formation of an "Extraordinary Program Office" (EPO).

5. The Promise of NIMA

Most who have tried to reconstruct the logic that put NPIC and DMA together into the National Imagery and Mapping Agency have concluded that it was the potential, profitable convergence of imagery and geospatial processes and products. And, while it is but a few years since the inception of NIMA, it is disturbing, nonetheless, that convergence has not occurred more rapidly and more completely. There remains the cultural divide between the Imagery Analysts (IAs) and the geospatial analysts (geographers and cartographers, by another name.) Is it merely human nature to resist such change, or perhaps that the presumed competition between the two groups or functions would inevitably produce winners and losers? Or, is there something more fundamental, some logic that would keep separate the two functions? Have we just failed thus far to find the unifying theme(s)?

Belief in the convergence of imagery and mapping is not limited to this side of the Atlantic. Less than a year ago it was announced in British Parliament that the Defense Geographic and Imagery Intelligence Agency (DGIA) would be formed by merging JARIC and Military Survey—respectively, the NPIC and DMA of the UK. Each, of course, has its own history and culture: JARIC dates from the Second World War, while Military Survey recently celebrated its 250th anniversary. The logic of the merger was that

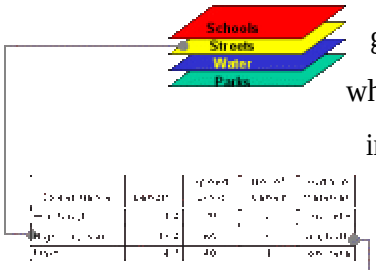
> *[benefits] will come as digital technology allows the work of the agencies to be increasingly integrated in future, including the production, storage and handling of similar sorts of data.…It is not just increasingly common sources of data and developing digital processes that are pulling the two agencies together. There is also an increasing requirement for the agencies' outputs to contribute to a common intelligence picture required by their defense 'customers' …*[8]

5.1 Convergence of Imagery and Geospatial Processes

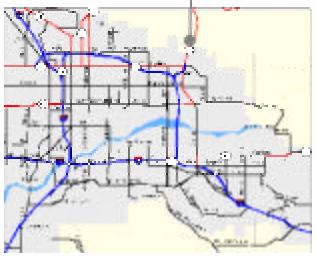
Imagery and geospatial activities, now housed in one organization, NIMA, *vice* two—NPIC and DMA—continue to elude one another to a large extent. Putatively, the vision behind the amalgamation of the two organizations was the emerging construct of geospatial

(digital) data that could intellectually encompass imagery and imagery analysis. This is vexing to some, while reinforcing the biases of others. Still, it is time to question the fundamentals of the assimilation argument.

A digital dataset of geospatial consequence has certain characteristics. Each "record" contains coordinates that relate it to a point, line, surface or volume about the geosphere. For most items, there is strong data typing, wherein the respective data types (or features) relate to interesting human activities and permit interesting operators to work on the items.



The dataset may include rivers and marshes, mountains and valleys, political jurisdictions, and the road to grandmother's house. The dataset can be displayed as a "map" with which we can facilitate any number of human activities. Each "record" in the dataset should also be "time-tagged" as well as geospatially referenced.



So, is an image such a dataset? Or, is it such a datum? A picture of grandmother can be geospatially referenced so that it can be viewed by clicking on grandmother's house's location on the map. How about a reconnaissance image, perhaps one from which the map was "made"—*i.e.*, one from which the digital dataset was extracted. It, too, can be geospatially referenced and accessed via the "map," but is it more than that?

From a GIS perspective, this discussion is reminiscent of arguments about the natural superiority of raster-over digital datasets, or the reverse. To the simplistic map user, the map is "the thing" and the digital dataset is a necessary evil, about which the less heard the better. To the GIS advocate, the digital dataset is "truth" and the map is just a view of the dataset, rendered, usually, by "rastering." However, the image from which the digital dataset features may have been extracted (*i.e.*, from which the map was made) cannot be "created" (or even

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[8] (UK) Select Committee on Defense *Fifth Report—THE DEFENCE GEOGRAPHIC AND IMAGERY INTELLIGENCE AGENCY.*

"recreated") by a rendering (rasterized or otherwise) of the digital GIS dataset.[9]

In a totally uninteresting sense, of course, the image—as it was erected on the focal plane of the reconnaissance satellite—was pixilated and digitized by the CCD array and captured as a two-dimensional array of numbers, which incidentally are of most interest to a rastering display device. Sufficient meta-data are captured and associated with the image to describe the "camera model," the time of acquisition, the ephemeris data of the collection vehicle, and the pointing angle—that, together with information about the earth's rotation—can translate into geocoordinates of the image (and its pixels.) As a database element, an image is rather unremarkable.

However, an image is something that eons of tinkering with the human hardware and software have allowed us to collect and interpret (task, process and exploit) "with the naked eye." Consequently, an image has a primary place in our consciousness. We can relate to an image in precortical ways that we cannot relate to a map. On the other hand, over those same eons, we have acquired the capability to extract features from an image and render it so as to be able to communicate (disseminate) it to others. We have also acquired the capacity to compile geospatial datasets not only from images but from our own wanderings and from words about the wanderings of others—simply, we have learned to sketch maps.

Finding, with the help of today's technology, easier and more useful ways of moving between images, GIS datasets, renderings, and words is the key to removing today's constraints on today's TPED. Seeking convergence between cartography and imagery analysis—and merging more closely together their respective work—is particularly promising.

The products are converging, most demonstrably in "image maps" where vector data sets--road and telecommunications networks, say—are overlaid on orthorectified imagery. The advantage of such products, *inter alia,* is that a dated vector data set can be overlaid on an up-

[9] In a technical sense, we have lost some information when we "transformed" the image into the vector data set (but, hopefully no interesting information). Of course, working with the vector dataset we also add other

to-date image, allowing the end-user to "update" his perceptions. Another, compelling example of the power of fusing vector data with imagery is to "drape" the image (or pieces of several) over a terrain model to create the now classic "fly-throughs."

The systems, too, are converging. IEC, the replacement terminal for the IDEX soft-copy imagery analysis system, will have the vector capabilities better known to the modern cartographer as well as the imagery analysis functionality more familiar to the IAs.

There is reason to believe that imagery analysts can move to a higher plane if they have some of the arrows in the cartographer's quiver. And, of course, for NIMA, the more in tune with intelligence analysis the cartographer becomes, the more valuable to the enterprise he or she becomes.

5.2 What Did the Geographer Know … and When Did He Know It?

The "electronic geographer"—*i.e.*, today's cartographer, creator of GIS datasets—exploits a satellite reconnaissance image by finding, measuring, and recording natural and cultural features of interest. This extraction of "feature sets" is highly stylized and is made measurably easier if the image is a soft-copy image and if the computer has a relatively simple toolkit that references points and clicks to the image's coordinate system—*i.e.*, georeferences the selected features—and provides a set of menu picks that embody the vocabulary of cartography—*e.g.*, unimproved roads, bridges, etc.

The cartographer is all about making accessible a set of geographic information, which can be used subsequently—generally by others as yet unspecified—to accomplish a task. The cartographer is about making a "map", by which an aviator might navigate, or a real estate developer might site a shopping center, or an armchair traveler might experience exotic places.

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information.

5.3 What Did the Imagery Analyst Know… and When Did She Know It?

By contrast with the geographer, the image analyst is about "storytelling"-like the legendary native scouts who could read subtle signs in the dust to recount the passage of game or interpret the activities of those who had camped there previously. In fact, however, the image analyst also "extracts features" such as the size and shape of new military construction, the extent and character of security fencing, and the direction of tank tracks through a trackless waste. Frequently, the extraction of these features is made easier for the imagery analyst by software tools that look suspiciously like those of the cartographer—and yielding deliciously similar digital data sets.

Alas, our image analyst does not generally regard the digital data set so derived as a product; it is frequently reduced to a textual description in an intelligence report. In this translation to intelligence prose, considerable information—all the bits and bytes that might support rendering a "real" picture *vice* a word picture—is lost to posterity. Worse than posterity, it is unavailable when that subject military facility is next imaged and must again be exploited, perhaps by the selfsame imagery analyst, who rereads her previous report and recreates in her mind's eye the picture.

In fact, we could capture much of the exploitation as digital datasets that would support:

- ✓ Illustrations for the intelligence report,
- ✓ Templates for smartly extracting an image "chip" for dissemination,
- ✓ Feature overlays on "imagery maps," and (thus)
- ✓ An aid to the subsequent exploitation of the next image of that target.

The technically inclined reader will note that such a derived digital dataset supports the ultimate in smart bandwidth compression. It permits faster dynamic overlays of historical images, and can more easily travel the "last tactical mile." Automatically compatible with ELINT-derived datasets, it advances us toward the holy grail of "multi-INT" TPED.

5.4 Convergent Systems and Convergent Products

To reiterate, a principal reason for the creation of NIMA was the recognition of the benefits of imagery and geospatial integration. The Commission has heard anecdotes of such integration (*e.g.*, specialized, tailored products for areas in the Balkans were developed), but was unable to find evidence of a strategic plan to make such cooperation routine. A recent study sponsored by the ADCI/Collection indicated that GIS tools that link diverse information to physical locations via layers could improve analysts' understanding of their intelligence problems. Such tools can also improve multi-INT analysis, if the data are presented in the proper format. In addition, use of such tools and the collaboration of analysts and collection managers can improve collection planning and efficiency.

The imagery and geospatial community is in the process of replacing its primary image-exploitation workstation, IDEX.[10] The goal was to finally move away from the light-table exploitation of film and toward soft-copy exploitation by computer. The technical challenge has always been the "need for speed." While just how big our satellite images are is classified, suffice it to say that they are Big! And they have gotten bigger just as computers have gotten faster. Simply rendering, panning, zooming, and rotating such images has remained just slightly beyond the reach of affordable desktop computers for two decades.[11] Ultimately successful, IDEX was a troubled development of custom hardware and software with display power still beyond commodity desktops. It has come to incorporate a number of powerful raster-image manipulation algorithms. It does not, however, support the more commonplace vector manipulations favored by Geospatial Information Systems (GIS). So, unfortunately, it does not promote the desired convergence of disciplines.

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[10] The roots of IDEX go back at least a quarter-century to a research effort, IDEMS, conducted by CIA's since-disbanded Office of Research and Development (ORD) on behalf of CIA's since-absorbed National Photographic Interpretation Center (NPIC). IDEX can also trace its roots to the Air Force COMPASS COPE effort at Rome Air Development Center (RADC).

[11] A lot of tricks have been tried. In the BR-90, Bunker Ramo (several times removed from TRW) married film projection with CRT technology and vector graphics. Rotating the whole CRT was also in favor briefly.

The latest-generation IDEX "replacement" is IEC. It does support the GIS operations. Good! It does not, however, quite match the custom-designed raster-image capabilities of IDEX. Bad! Unless it is modified so it does, the fingers of the hardcore imagery analysts will have to be pried from their IDEX stations. Without widespread and enthusiastic acceptance of IEC or equivalent, the promised convergence of imagery intelligence with mapping, charting, and geodesy will remain an unrealized dream.

5.5 A Tale of Two Cities

[*The story you are about to read is true. All the details have been changed by "security."*]

Washington, DC—Imagery Analysts (IAs) face the daunting task of searching a large, denied area in order to locate particular pieces of deployable military hardware. The alternative of taking high-resolution satellite imagery of the entire country and searching it, square meter by square meter, is prohibitive. Sufficient imaging capacity to do the job cannot be freed up, nor would it be feasible to image the entire country in a sufficiently short space of time to be confident that the hardware had not redeployed, hop scotch fashion, from as-yet-unimaged locations to previously imaged locations, in the interim. In any event, sufficient IA-hours are not available to conduct so brute-force a search.

St Louis, MO—Geospatial Analysts review the geography, topography, and cultural features—road, rail, and power networks; hills and dales, forests and clearings—correlated with previous sitings (sightings) of such equipment. A factor analysis later, the Geospatial Analysts prepare a "map" (vector dataset) that provides the template for where to search—where to image and where to exploit.

Washington, DC—The IAs get the picture!

But, do they really get the picture? Is this a story about IAs who "subcontract" for collateral information? Or, is this a story about the ascendance of the Geospatial Analysts who, faced with a vexing intelligence problem—"map" the locations of subject hardware—and proceed to produce said map, showing probable future- and confirmed present-sites, with workaday assistance of trained eyeballs (to be replaced, when cost-effective, by computerized pattern recognition)? Or, is this a triumph of "collaboration?" Or, does it presage the next generation of intelligence professionals, schooled in *both* imagery and geospatial analysis disciplines?

More generally, NIMA is examining the feasibility of collocating regional specialists to encourage better integration of imagery and geospatial information. The Commissioners were made aware of a planned "experiment" to integrate Latin America imagery and geospatial analysts, *i.e.*, collocate those analysts who are Latin American specialists. The Commission lauds this "experiment" but urges NIMA to include the experiment as part of the larger development of a geographic information database. Furthermore, NIMA should

set explicit goals and performance metrics to determine whether collocation and integration works, how well it works, and how it may be extrapolated to other parts of NIMA.

5.6 "Magic Maps"—Another Kind Of Convergence

Imagine being able to unfold a paper map and look at it "through the lens" of a computer network appliance. Suddenly the paper map would spring to life, show terrain in 3-D, show moving mobile SAMs actually moving, and see their effective threat envelope as upside down sugar loaves. And, as you moved the paper map from side to side, or rotated it, the "erected" data images would move in synchrony, allowing you to view the terrain from any perspective. Just such technology is emerging from the laboratory. Augmented or mixed reality (AR) research aims to develop technologies that allow one to mix or overlap computer generated 2-D or 3-D virtual objects on the real world. Unlike virtual reality that replaces the physical world, AR enhances the physical reality by integrating virtual objects into the physical world, which become in a sense an equal part of our natural environment.[12]

This fusion of computer-generated visualizations of vector data sets and paper maps is particularly intriguing as it may allow us, literally, to overlay new technology on legacy products. And, of course, it can be "multi-INT," fusing additional data derived from HUMINT and SIGINT. From the user's point of view, an especially appealing characteristic of such a "magic map" is its graceful degradation in the face of computer malfunction. We have augmented the map with computer-generated displays, but, if all else fails, the old standby map is as effective as it ever was. Moreover, the ability to overlay vector data onto maps in this way allows the soldier to simply mark up his map with traditional symbology without having to shift his gaze or attention away from the paper. Imagine sending an update to be marked on a map without having to use coordinates—

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[12] "The Pop-Up Book Picks Up Magical Dimensions," *New York Times*, 12 October 2000, p. E7. See also http://www.hitl.washington.edu/magicbook/.

sending, as it were, directly to the eye of the soldier who needs to annotate his map, or to the navigator or mariner who needs to update his chart.

6. NIMA and Its Stakeholders

NIMA is at once a Department of Defense Combat Support Agency and a member of the Intelligence Community, as is the National Security Agency (NSA). Each tries to balance its national intelligence mission with its more immediate support to the warfighter. The extent to which either can be more or less successful depends upon the degree to which its separate reporting lines—to the Director of Central Intelligence in one case, and through to the Secretary of Defense in the other—are synchronized with each other as well as with CIA, the uniformed military services and the Joint Chiefs of Staff. This is a hefty set of players to huddle around one playbook.

When such diverse players must queue up to the same bank window, it is not surprising that they try to pick each other's pockets. When there seems to be too little imagery and exploitation for the competing intelligence processes—military and nondefense, national and theater, strategic and tactical, short term and long term—it is not surprising that tensions arise.

NIMA, an unlikely marriage by some lights, and a come-lately to the game, suffers most. It may be a reasonable stratagem to allow operators in the field to treat imagery intelligence as a free good—more like oxygen[13] than ice cream—but that simply means that, at the highest levels of leadership, there must be an awareness of its true cost and value, and a willingness to cooperatively ensure that the resources are made available. Having birthed this agency, defense and intelligence leadership must commit themselves absolutely to its health and well-being. It is that important.

[13] As with oxygen, information ought not be denied: the higher we fly, the more we need.

At the highest level, we are in for a rude awakening because the reliance on information superiority to deliver bloodless victory demands intelligence capacity, especially imagery intelligence capacity, well beyond that which current investments can provide. Defense and intelligence leadership must redress this variance and reconcile themselves and their accounts to support NIMA. This will mean resisting other pressures, the true test of leadership. Firm decisions, not just continuous deciding, are required.

To anticipate a recommendation made later in the report, the Commission believes that a new systems engineering and acquisition element should be formed and staffed with a caliber of talent not now readily found in NIMA, or in the Intelligence Community at large. In fact, the Commission refers to this creation as an "Extraordinary Program Office," by which we mean to connote a significant departure from the way US government components are usually configured. To get the talent required, the Commission suggests that the Director of Central Intelligence and the (Deputy) Secretary of Defense take a personal interest in persuading key contractors to relinquish to the government, for a defined period, a small number of their own very best personnel. With the help of Congress and the cooperation of industry, all the details of transfer and compensation can be worked out if, and only if, there is personal commitment by senior defense and intelligence leadership—leadership committed to making things, the right things, happen.

7. NIMA and Its "Customers"

7.1 Kudos from Users

The Commission found that in the field NIMA received praise up and down the line, from the Commanders-in-Chief (CINCs) to field-grade operations officers and below. Washington-area customers, too, had compliments for the NIMA service they currently receive, but they evinced concerns about the future. Much of today's relatively happy state of affairs is based on personal relationships and long-term expertise; the concern is that as the present cohort retires the situation could deteriorate.

The NIMA Commission concludes that NIMA works hard at understanding its customers and, by and large, is quite successful at it.

7.2 Support to CIA and DIA

When NIMA was formed, CIA and DIA imagery analysts were moved into NIMA. Although some remained assigned to components within DIA and CIA—especially in the DCI Centers—the majority of all-source analysts in CIA and DIA components "lost" their direct imagery support.

This contrasts with the military commands who retained management and operational control of their organic imagery support when NIMA was formed, and have since enjoyed the addition of NIMA IAs assigned to their command and under their operational control.

Support to CIA and DIA all-source analysis is a significant part of NIMA's mission, as D/NIMA well understands. He has made it a priority and told the Commission of his plan to transfer 300 NIMA positions (60 per year, 2001-2005) from cartography to imagery analysis, all of whom would remain in Washington, DC, to support Washington customers and rebuild NIMA's long-term analysis capability.

Despite D/NIMA's efforts to reassure DIA and CIA, some seniors at the two agencies remain concerned about the lack of long-term research in NIMA and the lack of collaborative analytic efforts between NIMA, CIA, and DIA. The Commission discussed options that might alleviate the angst of CIA and DIA and, in the end, decided there was no single, ideal model for how support to these two organizations should be structured—a variety of models, including the present one, could work given sufficient resources, expertise, and interagency cooperation and trust.

The Commission endorses the plan to fill the 300 positions (60 per year, 2001-2005, transferred from cartography) with imagery analysts and would stiffen the resolve of D/NIMA to keep them all in Washington to rebuild NIMA's long-term analysis capability and to focus on neglected national issues. To the leadership at CIA and DIA the Commission counsels patience and good communication as NIMA rebuilds its analytic cadre; all-source analysts should take the initiative to reach out to NIMA IAs.

7.3 Customer Readiness for Change—The Paper Chase

NIMA staff believe, correctly, that many of their customers continue to prefer using NIMA's traditional information products (*i.e.*, hard copy) rather than newer digitally based (*i.e.*, soft copy) technologies. The Commission was treated to the old saw about the trooper who draws his .45 (now, 9mm), shoots a hole in a paper map, and asks pointedly if the digital appliance, so treated, would still perform as well. This is, indeed, a cautionary tale; there is a certain durability to a paper map product. Evidence of just how durable they are (and how venerable they can be) is attested to by the palettes of dated paper maps waiting to be deployed.

The argument is not whether, *in extremis*, a soldier can depend more on a paper map. Even if paper (or maybe Kevlar) were the required medium of issue, there would still be a question as to where and when the map information should be overlaid on it—at an earlier date convenient to economy-of-scale big presses, or "just-in-time" at the edge of battle, which our trooper forgot to mention almost always seems to occur on the corners of four contiguous map sheets.

The real argument is whether the speed of change of doctrine matches the rate at which technology refreshes itself. Is this a revolution in military affairs, or slow evolution? We should rethink the reliance a soldier must have on his paper map talisman when his logistics train knows where he is and what he needs, when his vehicle knows where it is and where to go, and when his fire-and-forget weapon knows its launch site and aim point.

When doctrinal inertia demands that legacy systems and processes be kept in place at the same time as new demands are levied for new technologies and products, NIMA's problem is to fit it all in a fixed budget.

The solution is twofold.

First, legacy products should be outsourced, or otherwise fairly costed, and users of legacy products must be "cost informed" as to the resources they consume. Ideally, the valuation should be emphasized "at point of sale." One way to do this, which is generally resisted, is

to price the products and go to "industrial funding," a euphemism for charging the users—*i.e.*, turning consumers into customers.

The contrary argument, which has admitted merit, is that information/intelligence should, like oxygen, be free.[14] Otherwise, to their detriment, warriors will neglect to "buy it," just as they frequently do for training or spares. One way to resolve this apparent paradox, not surprisingly, is leadership.

Second, insofar as new demands for new-tech products result from the introduction of a new weapons system, the cost of the geospatial product to support the system should be an identifiable variable in the "total cost of ownership" of that system. It should be factored into original acquisition decisions no less than fuel costs, ammunition, training, or spares. And it should be programmed and budgeted in the same manner and with the same vigor as the system itself.

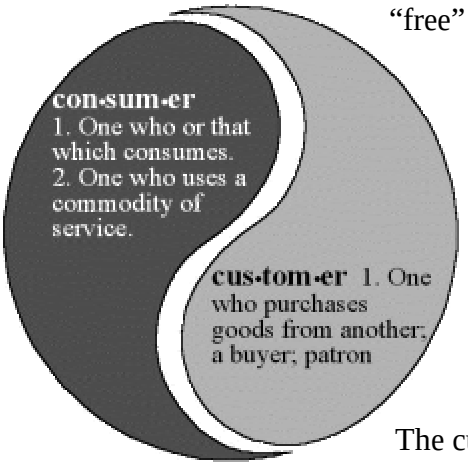
7.4 Turning Consumers Into Customers

The Commission observes that national technical means (NTM) imagery appears to be "free" to government agencies, while use of commercial imagery generally requires a distressingly large expenditure of (largely unplanned, unprogrammed) O&M funds. This perception of NTM imagery as a free good, not surprisingly, influences the willingness of those organizations to seriously consider purchasing commercial imagery. Two suggestions for resolving this problem have been suggested to the Commission.

The solution, which the Commission favors, is to remove cost from the user's equation. That is, to set aside a central commercial imagery fund—administered separately and immunized from "embezzlement" by the Services, *inter alia*—against which components

[14] While some argue users should have to pay for their imagery and geospatial information, others argue that information dominance cannot be achieved by rationing the information in this way. Surely, *Joint Vision-2010/20* did not envision that the turbo-charged engine of information dominance would need to be fed quarters, more like a parking meter.

would then draw transparently to acquire commercial imagery, which would then seem as "free" to them as does NTM imagery.



While appealing, this solution ultimately must invoke a "rationing" scheme just as does NTM, inasmuch as the fund would seldom be sufficient to satisfy every demand. Only half jokingly, this can mean that the products are sometimes "freely unavailable."

The current solution is to "ration by price." Commercial products come already priced, which allows the users to be accurately "cost informed" as to the value of the resources they consume—ideally as they are about to consume them.

As previously pointed out, opponents argue that information/intelligence should, like oxygen, be free. Otherwise, to their detriment, warriors may neglect to "buy it," just as they frequently do for training or spares. To repeat: one way to resolve this apparent paradox is enlightened leadership.

7.5 NIMA "Commercialization" Strategy

If NIMA is in the information business, to what degree should it emulate commercial information providers? Modern information architecture argues that all of NIMA's information holdings be accessible *via* the "Web"—the Secret and Top Secret versions of Intelink, as well as a Virtual Private Network like OSIS—and that applications be similarly Web enabled and/or Web-served. Here, we consider whether NIMA's "business processes" should follow an e-business model, as well.

NIMA might serve its consumers best if it were to adopt many of the stratagems of commercial e-business. For example, NIMA might:

- ✓ "Advertise" its products by "pushing" news about them to interested subscribers—*i.e.*, those who "opted in" for e-mail notification—and it might deliver with its products accompanying "banner ads" that allowed users to "click through" to additional product and applications information, and doctrine. The goal is to educate the subscribers in context. NIMA's products, maps and images, have intrinsic "eye appeal" and would be well suited to this.
- ✓ Advertise, in context, ancillary services such as training and new applications, both COTS and government-off-the-shelf (GOTS) over the protected Webs; and deliver these products and services over the same media.
- ✓ Use "hot links" on its own products—the soft-copy maps and images it delivers to subscribers—to allow users to click through to substantive collateral materials.
- ✓ Embed context-sensitive training and educational materials within the NIMA products, and enable the user to click through to take advantage of these.
- ✓ Arrange for hot links on other INT products to direct users, in context, to relevant supporting NIMA products.
- ✓ Permit qualified imagery vendors and value-added suppliers to "market" directly to the national security community—this would include qualified outsource enterprises to display available products and services, take orders directly, and fulfill them directly with suitable copies, as appropriate, to NIMA libraries.
- ✓ Encourage commercial vendors to keep (*i.e.*, to "replicate") their own archives on-line accessible over the USG's classified and PVN networks.
- ✓ Provide multiple access pathways to NIMA library holdings, including "commercial vendor" pathways so that goodwill associated with past vendor performance can guide a user's browsing and extraction from archives.
- ✓ Ensure that all products and services—from USG as well as from commercial vendors—carry a meaningful "price sticker" that allows consumption decisions to be "cost-informed."

- ✓ Depending upon "industrial funding" decisions, enable account reconciliation with online payment transactions and balance checking; consider extending the transactions to "real" credit card purchases from qualified commercial vendors who have been invited online.

7.6 The Short Attention Span of Most Consumers

The Commission can confirm a shortage of long-term analysis in NIMA—although this neglect does not seem to be limited to NIMA, but rather prevalent throughout the Intelligence Community. As has ever been the case, absent constant vigilance, current intelligence tends to drive out long-range research. A complicating factor, for NIMA, is the fact that the long-term analysis that languishes is more properly the province of the national—*i.e.*, nonmilitary—consumers. Notwithstanding the real scarcity of long-term efforts, the perception on the part of the national consumers may be exaggerated. Beyond the addition of collection and exploitation capacity, the alternative is better communication and credible management of expectations.

The Commission does not believe that NIMA can, itself, effect a rebalancing of short-term/long-term analysis, nor redress the "national-tactical" imbalance, if there is one. It is, in fact, the responsibility of the Director of Central Intelligence, in concert with the Secretary of Defense, to make these trade-offs. Even they, however, are prisoners of a well-meaning, but somewhat feckless, prioritization embodied in PDD-35.

Once envisioned as a justification for, and ratification of, the Intelligence Community's allocation of resources—an allocation that would purposefully reduce or eliminate coverage of some issues and areas, accepting the attendant risk—PDD-35, instead, has not one but two categories of highest importance, another category of highest importance for transient issues, which are remarkably intransigent, and a still higher highest priority of support to US deployed forces. And, of course, this "guidance" is coupled with an imperative to "miss nothing else of critical importance!" The Commission does not debate that these are all of the very highest importance, but does observe that this does not really help make hard allocation decisions. More important it does not help condition expectations nor suppress appetites.

The Commission reiterates that the shift toward short-term issues and away from long-term analysis is neither unique to NIMA nor of NIMA's making. Nor is it solely a reaction to tactical military concerns. In fact, it is a response to pressures from the policymakers as well as the operators. Like it or not, this is the age of "interactive TV news"--when CNN speaks, the NSC often feels compelled to act! The competition that pits intelligence against the news media is corrosive; the news media are not bound by the same needs for accuracy, which is always the enemy of timeliness.[15] The consequences of a CNN misstep is (perhaps) a retraction the next day; the consequences of ill-advised action, misinformed by over hasty intelligence, can be far reaching. Notwithstanding, pressures to focus on the immediate are relentless; we commend the Intelligence Community for its attempts to resist and urge continued efforts for the vital long-term work.

7.7 Tension Between "National" and "Tactical" Users

While understandable, the Commission believes this perception misdirected. Worse, the "national-tactical" debate has become a rallying cry for a competition that is already disruptive, and threatens to become destructive.

The context for this issue can be found in a number of recent events and trends: (1) the increasing number of military contingencies requiring intelligence support; (2) the overall increase in intelligence requirements worldwide; (3) insufficient collection capability and too few imagery analysts; and finally, (4) the absence of a single overwhelming target of focus such as the Soviet Union. All of these factors influence the policy/mission rationale and underpinning for intelligence support provided by NIMA.

The Commission finds that the issue is not one of national intelligence requirements versus tactical intelligence requirements, nor is it strategic versus tactical. Rather, the issue is one of balancing long-term intelligence support and analysis versus short-term (*i.e.*, crisis support) intelligence support and analysis. Largely because of the operational pressures described above, perceptions (but not necessarily data) exist that NIMA emphasizes support to the

[15] As in "haste makes waste."

warfighter at the expense of building long-term analytical capital and support to the national intelligence community. In reality, this is a complex issue, but perceptions have contributed to beliefs that the national Intelligence Community is being shortchanged. The Commission suggests that this issue be framed in the "long versus short" context, but more important that the community needs to recognize that NIMA provides support to a wide range of customers at all levels, all in support of national security goals and objectives.

The Intelligence Community leadership must work to defuse this issue, and certainly refrain from itself throwing gasoline on the fire.

8. Is There a "National Versus Tactical" Problem?

The Commission heard substantial testimony about a so-called "national versus tactical" problem, namely a concern that NIMA's support to national customers, such as CIA, was being sacrificed in order to support the operational demands of the military customers, such as those at European and Central Command. Here, we attempt to separate out the real issues and concerns, and offer some strategies for their mitigation and possible relief.

8.1 A Characterization of the Problem

Many officials complained that NIMA's tasking, collection, and exploitation strategies had a negative effect on our understanding of long-term intelligence issues—such as the development and spread of weapons of mass destruction—because of a tendency to emphasize military operational needs, such as those of Operations Southern Watch and Northern Watch. While no one doubted the legitimate need for information about the threat to US forces operating in the area of those activities, many did question whether the volume of imagery collection, the details of imagery collection, or the strategy used to ensure imagery collection was appropriate in light of other intelligence needs.

First and foremost, the Commission was concerned that the discussion about this problem lacked rigor in terms of thinking and taxonomy. While discussants revealed important problems related to imagery collection and exploitation on longer-term issues and questions, they seemed to be describing not one but various problems which in the aggregate could contribute to a perception of a "national versus tactical" problem. Among these were competitions between strategic and tactical intelligence targets, strategic and operational

intelligence targets, and long-term versus short-term intelligence information needs.

It is overly simplistic to define any customer's requirements slate as being purely focused on national, strategic, operational, or tactical problems; both policy-makers and military commanders alike deal with problems that vary in scope and duration. The accompanying diagram may help us characterize this problem: it points out that this is (at least) a two-dimensional problem. There is the question of who the consumer is for the information—a national-level decisionmaker or an agency such as CIA that is oriented first and foremost to that national policy level, or operators in the theater. And there is the separable question of whether the information primarily serves a strategic or a tactical purpose.

> In the case of Usama Bin Ladin, it is primarily of national-level concern, but decidedly tactical—*i.e.*, short-term focus.
>
> In the case of "Northern Watch" or "Southern Watch—nationally directed, but theater-executed mission in Iraq—the theater is principally concerned, and the focus is also tactical.
>
> In the case of Weapons of Mass Destruction (WMD) the focus is more strategic-long-term and principally (although not exclusively) an item of national-level interest.

What unifies the two dimensions, and best characterizes the real problem (as opposed to the atmospherics) is the issue of long-term versus short-term.

8.2 The Need to Turn Down the Heat

This issue disturbed the Commission because of the extent to which it had become polarized—or "politicized"—and bruited about publicly by senior DoD and Intelligence Community officials with little supporting evidence.

A few chose to use this ill-defined problem as yet another reason to condemn NIMA, revisit its creation, and question its future viability as the nation's provider of imagery and geospatial information. Some among the National Intelligence Council (NIC) and CIA continue to dwell on having "lost NPIC" and continually fret about NIMA's role as a

combat support agency. These concerns discolor their perceptions of NIMA and threaten to reduce their own and NIMA's overall effectiveness.

The Commission believes that this issue is sufficiently controversial that it requires the DCI's and SECDEF's attention, in particular, to moderate the political differences and address the real problems.

8.3 Identifying Some Component Problems

Concerns about NIMA support to national and tactical customers are best dealt with in terms of specifics, rather than casting the problem as an overall competition. The Commission believes that it is unhelpful to define this issue in such broad terms, and especially perilous to raise it so often and so publicly.

Fundamentally, the problem reflects the scarcity of imagery resources, both collection and exploitation, to deal with today's complex slate of intelligence requirements, especially in the Middle East, Southwest Asia, and North Africa. Whereas the geography of the Soviet Union allowed for many imagery collection opportunities of mutual interest to the national and operational communities, the geography of today's adversaries and interesting intelligence targets create competition both within countries and between countries. The current shortage of long-term exploitation derives primarily from the loss of skilled imagery analysts and the need for the remaining few to spend their time mentoring new hires.

The Commission believes that, while this "national versus tactical" contretemps tends to be overheated, it does contain real issues that merit attention, both by NIMA and by its consumers and stakeholders. Among these real issues are the following:

Lack of collection feedback—One difficulty with current processes for tasking imagery collection and/or requesting exploitation is the lack of information available to a requester as to the status of the request. FEDEX™ is the invidious comparison—when one sends a package, it receives a unique identifier, or tracking number, which is provided by the sender to the intended recipient. Both feel satisfied that they can track accurately the progress of the package. No such capability today attaches to requests for imagery and/or exploitation.[16]

Poor collaboration and communication—Contenders for imaging capacity often have more in common than they realize. The DCI, in his *Strategic Intent*, has given a high priority to improvements in communications infrastructure for collaboration. Substantive managers need to value more the collaborations that take place today, and to find ways to structure their issues and their incentives so as to increase collaboration, which promotes both efficiency and understanding.

NIMA as mediator/facilitator—The Commission found that NIMA gets mixed reviews about its role as mediator of contentions and somewhat better reviews about its role as a facilitator of collaboration. Not surprisingly, the "winners" always like the mediator better than do the "losers." Of course the goal of good mediation (getting to yes) is for neither party to feel disadvantaged. NIMA can help, but the tone has to be set by the Intelligence Community leadership writ large.

Scarcity of imagery analysts—NIMA lost a lot of its expertise, both at its creation and in the overall downsizing of IC personnel in the early 1990's. The departure of NPIC image analysts from the imagery analysis business (many are involved in other CIA analytic functions today) reduced the amount of high-level collection and

[16] Or for map production either, for that matter.

imagery analysis expertise, some of which could help mitigate the current concerns through more creative collection strategies. The Director of NIMA is to be commended for recognizing this problem and for formulating a creative plan to rebuild the imagery analytic experience base.

(Lack of) Proximity of imagery analysts to their all-source customers—By all accounts, the placement of NIMA imagery analysts at the military commands is highly productive: proximity to the all-source analyst, cognizance of the specific problem set, and collocation with other relevant sources of information all contribute to the heightened ability of the imagery analyst stationed at the commands. Yet CIA and DIA, by virtue of the arrangements made at the creation of NIMA, are bereft of such dedicated, on-site support.[17]

A focus on short-term problems rather than long-term problems—A focus on short-term problems rather than long-term problems dogs NIMA, as mentioned previously. As with the rest of intelligence, the imagery enterprise has been driven much more toward a current intelligence focus, whether for national or military customers. Intelligence problems that require more long-term research focus, such as WMD issues, get short shrift in the press of daily business.

8.4 Strategies for Relief and Mitigation

Relatively new to the scene are the Assistant DCIs for Collection and for Analysis and Planning (ADCI/C and ADCI/AP, respectively). The Commission applauds the steps already taken by the ADCI/C in improving communication between collectors and consumers, and the creative approach to problems of contention embodied in some studies conducted by his Advanced Collection Concepts Development Center. There is more that he, in concert with the ADCI/AP, can do to institutionalize collaboration and to shorten the loop between requesters and collectors.

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[17] There are NIMA analysts embedded in certain operational activities; this is distinct from more general "command" support to all-source analysts.

In order to relieve the shortage of imagery analysts and restore more emphasis to long-term issues, D/NIMA's strategy is to move 300 positions (60 per year, 2001-2005) from cartography to imagery analysis. Despite a request from the field for half of these, D/NIMA is determined to keep all in the Washington area. The Commission endorses D/NIMA's decision that all should remain in the DC area and be dedicated to long-term issues, which will help restore balance.

8.5 Some Longer-Term Concerns

Some mistakenly believe that with EIS and FIA the contention for collection will be eliminated—that we will no longer be collection limited. But if history is any guide, more collection capacity will be more than compensated for by increased demand.

Even in terms of anticipated demand, the Commission has reservations about whether commercial imagery and airborne assets will be able to deliver on their promise. If not, FIA will fall short of expectations and we will be little better off than now—perhaps worse because people will have built availability assumptions into their systems and concept of operations (CONOPS) that will be expensive to repair.

9. NIMA and Its Peers and Partners

NIMA could not begin to serve its customers without the active collaboration of other departments and agencies, as well as commercial suppliers. All of USIGS is not NIMA and NIMA is not all of USIGS. NIMA does and must rely on others. Maximizing the benefit of alliances within and without government is the only smart way for NIMA to do its business.

9.1 How NIMA Is Viewed by Industry

Industry is generally concerned with NIMA's long-term vision and architecture, business and contracting practices, and maturity of partnership. Although NIMA has taken steps to identify an architecture for the United States Imagery and Geospatial Service (USIGS), many in the industry contend that the requirements are more prescriptive than necessary. Furthermore, the architecture cannot replace a vision of how NIMA sees itself, especially what it considers to be its own core capabilities.

The industry contends that NIMA is an unpredictable business partner and hints that it may lose the support of its industry partners as their commercial opportunities mature and overtake the business base currently provided by NIMA.

NIMA has many contracts to support its geospatial requirements, but the industry contends that they are of short duration, unpredictable schedule, and limited in scope and funding. Additionally, only a select number of prequalified prime contractors provide a limited production capability and only to supplement concurrent NIMA capabilities.

The production contracts are subject to provision by NIMA of source data, which may or may not be provided in a timely manner. The industry contends that because of the unpredictable availability of source data, arcane business practices, and burdensome contracting regulations, it is unable to provide real-time feedback to its end-consumers (*i.e.*, NIMA's customers).

Some in industry believe NIMA performs most of its own information technology work—services, R&D, and integration—when most of it could easily be performed by the private sector. Of greatest legitimate concern to the private sector (and to the Commission) is an apparent NIMA penchant for the government and the contractor to *jointly* integrate various functional and mission-related hardware and software tools. Contractor preference, not surprisingly, would be for NIMA to contract out the entire process as a turnkey service.

Almost all the foregoing applies to NIMA's geospatial production. So far, NIMA has had minimal interaction with the private sector on matters of imagery analysis, even though some in the industry contend that NIMA could profitably offload some long-term analysis work to contractors. The Commission believes that this may be worth pursuing, especially for the more esoteric, science-based exploitation.

9.2 NIMA and the Other INTs

As the lead agency for imagery and geospatial information, NIMA has an important role to play in collaborative efforts across agencies. NIMA comes to the fore on two counts: first, it is the presumptive USG leader in setting standards for imagery and geospatial processes; second, NIMA "owns" the geospatial construct which is the most likely touchstone for collaboration among, and fusion of, the INTs.

The Commission notes with satisfaction that NIMA strives to play a constructive role in interagency and commercial fora that seek to set standards for the mechanics of transmitting and storing imagery, and to advance the art and practice of GIS and related disciplines, including, for example, standards for compression and storage of video. NIMA needs to be a leader—but also a listener—in the Open GIS Consortium (OGC). NIMA's objective must be to ensure that USG needs are well served by industry standards. Standards set in disregard of the commercial market do not generally serve the long-term interests of the

government. The Commission is fond of the definition that "industry standards are products that ship in volume."[18]

With respect to collaboration and fusion of the various collection disciplines, or INTs, the Commission believes that NIMA should hold a premier place because it "owns" the geospatial construct. NIMA provides the logical context for fusion of SIGINT, especially ELINT, with imagery. And SIGINT, despite its own suffering, can add considerable value to imagery's contribution.

As previously mentioned, the coming availability of commercial imagery, and associated COTS processing and exploitation tools, threatens continued US information dominance. Note, however, that there are no current plans (nor market demand) for commercial SIGINT. Successful integration of the various INTs, therefore, may provide the United States the competitive edge it requires in order to fulfill *Joint Vision 2010/20.*

However, there does not appear to be a full-fledged, coherent effort to converge SIGINT with imagery (a process that we used to call, "fusion").[19] Among the questions that should be answered without delay are two. Where in the stream from collection to end-use should this convergence be applied? And whose responsibility is it to drive the convergence?

A likely answer to the "where" question is that the convergence should be effected as far "upstream" in the collection-processing-exploitation process as possible, but enabled all the way down to the end-user. In this case, as elsewhere, the Commission observes that what should be a continuum from NIMA to ultimate end-user actually has a discontinuity—NIMA services the higher echelons (as "national" customers), while the Services architect and provision echelons below. There must be an architectural function that subtends both the designs of NIMA (more generally, of the "national" systems) and the last tactical mile

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[18] Thought to be attributed to Scott McNealy, Chairman of the Board and Chief Executive Officer, Sun Microsystems, scottg.mcnealy@sun.com.

[19] There are efforts—referred to variously as "cross-cueing," "tip-off," *etc.* However, this differs from the fusion for analysis and decisionmaking envisioned here.

designed by the respective services. ASD(C3I) must acknowledge responsibility for end-to-end architecture and take more forceful cognizance of the discontinuities that exist.

To whom should we entrust execution of the Imagery-GIS-SIGINT fusion? Against all odds, the Commission feels the answer may well be NIMA. Other usual suspects include NSA and NRO. True, ELINT has traditionally displayed itself geospatially. True, the NRO and the SIGINT enterprise each have more dollar and engineering resources than NIMA. True, NIMA is a new organization striving to fulfill its promise. True, NIMA does not yet inspire confidence in others (and may lack confidence, itself). Still, the Commission argues, the responsibility is logically NIMA's. Why? Because the geospatial construct is the obvious foundation upon which fusion should take place.

Ineluctably, most military "business processes" are planned and executed within a geospatial reference framework. Within the National Security Community, NIMA "owns" that framework. It sets the standards, and provides the controlled base data. It provides the integration platform for data from other intelligence sources. As a consequence, NIMA should be empowered to specify the "desktop"—the way in which users interface with, request and manipulate data of all sorts.[20] For nearly every task, the screen is the map and thus the point-and-click entry to nearly all information. This desktop metaphor closely matches two-and-a-half of the three critical questions any analyst or operator asks: namely, "What is happening here? Where are the…?" Even most "When…?" questions can be posed within this contextual framework, providing that all data are "time-tagged," as the Commission argues, elsewhere, as they should be.

9.3 NIMA and Foreign Government Activities

The Commission was surprised and impressed by the extent to which NIMA's MC&G relationships with foreign governments yielded cartographic data that offset considerable cost that NIMA would otherwise incur.

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[20] However, the Commission acknowledges that the Defense Information Services Agency (DISA) may have a "process" claim to the desktop specification that equals NIMA's "substantive" imperative.

10. NIMA and Its Suppliers

10.1 NRO and FIA

The mission of the National Reconnaissance Office is to enable US global information superiority, during peace through war. The NRO is responsible for the unique and innovative technology, large-scale systems engineering, development and acquisition, and operation of space reconnaissance systems and related intelligence activities needed to support global information superiority.

The NRO designs, builds, and operates the nation's reconnaissance satellites. As one of NIMA's imagery suppliers, the NRO plays an important role in helping achieve information superiority for the U. S. government and Armed Forces. Through NIMA, *inter alia*, NRO products can warn of potential trouble spots around the world, help plan military operations, and monitor the environment.

The discerning reader will note that this is not precisely the way the NRO would characterize itself. The Commission is anxious to emphasize the role of the NRO in context: the NRO is a supplier to NIMA—true, the NRO is more venerable and better financed, but its role is properly thought of as a supplier to NIMA. It is important for the NRO and the Intelligence Community to get this picture. In part, it is a previous failure to understand the relationship that has led to the collection-centric behavior of the Intelligence Community, which funded FIA without real thought to funding imagery TPED.[21]

FIA, the Future Imagery Architecture, is the program for replacing the current constellation of satellite imaging vehicles, and associated ground processing systems. For the first time, the design of an NRO system was dictated more by requirements and less by technology, and was "capped" in terms of overall system cost. As a consequence of the requirements

[21] Of course, there is a countervailing view that the NRO, *via* technology pull, provides the engine that drives NIMA and is best left in the driver's seat, as well.

versus technology change, it will end up delivering imagery, much of which could be acquired from commercial imagery providers whose technology is not far below that of the NRO. As a consequence of the funding cap, there are currently five capabilities validated by the JCS, which FIA will not provide. From the Commission's perspective, the phasing of FIA, which delays integration of airborne and commercial imagery into the "system," is suboptimal.

10.2 DARO, Where Are You When We Need You?

NIMA has the overall national imagery mandate but, with the recent demise of the Defense Airborne Reconnaissance Office (DARO), it is unlikely that NIMA can adequately provide for the tasking, processing, exploitation and dissemination (TPED) aspects of aerial photography, whether from manned or unmanned aerial vehicle (UAV) imagery collection platforms.

From the perspective of this study, DARO needs a successor. The Intelligence Community, civilian as well as military, cannot let the issue of a focal point for airborne reconnaissance remain unaddressed. A clarion note should be sounded, for the Congress and for the Services, that there should be convergence and economies of scale across the future of airborne recce.

The Commission also wonders whether theater airborne imagery reconnaissance may become a "net minus"—a drain on imagery capacity rather than a contributor. The problem is that the current generation of airborne imagery platforms is becoming increasingly vulnerable as anti-aircraft technology improves. Either the airborne imagery platform will have to fly at a longer standoff, decreasing its resolution and thus its utility, or it needs to be protected. Thus, prudence dictates that the recce aircraft fly only under the protection of an air cap, which in turn requires an AWACS aloft. But in order to ensure the survivability of those assets, and to give them retributive targets in the event of hostile lock-on, the mission planners need to know the location of SAMs which, if mobile, require recent imaging, which means tasking, *inter alia*, satellite imagery assets. An alternative to manned reconnaissance platforms is, of course, the UAV, which was to have been so cheap as to be "disposable",

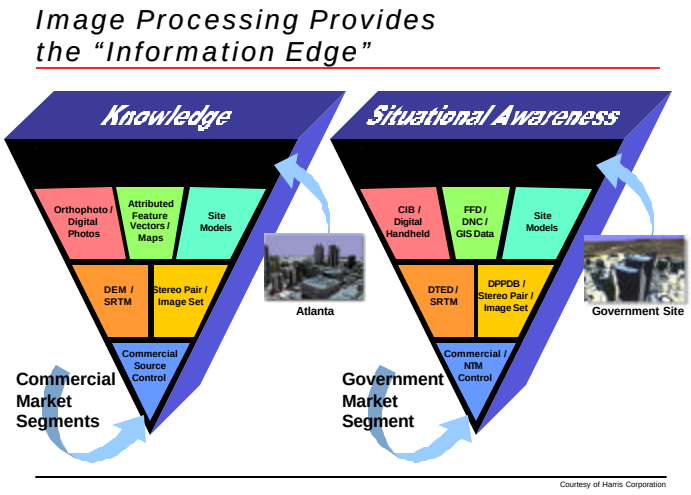
but which has turned out to be so expensive that it, itself, has become a high-value asset that must, in turn, be protected if flown in harm's way, which requires imagery, etc.

10.3 NIMA's Changing Role in a World of Commercial Suppliers

NIMA faces a fundamental business problem that it must solve if it is going to lead the information edge.

Currently, NIMA owns the market for geospatially referenced intelligence analysis, both in terms of being the largest customer for these intelligence products and in terms of being the main supplier of the digital source for these products. Thus, NIMA is in the unique position of being the largest customer for and the largest supplier of these materials. This monopoly is starting to erode, however, as a commercial market for competitive business intelligence based on analysis by and from commercial sources grows. NIMA's role is also beginning to erode as the contractor base finds it harder and harder to justify doing business with NIMA when NIMA is viewed as being neither a steady and reliable customer nor a steady and reliable provider of source data sets.

As one can see in the accompanying graphic, the distinction between the commercial market and the government market has come down to a single point, the source for the visual analysis. The commercial world relies solely upon commercial and open sources; whereas, the government can also use national assets for its source materials. The differences beyond the source are purely semantic, and the ultimate product is the same– "The Information Edge." The commercial world speaks of competitors while the government speaks of enemies. The speed of the marketplace is the same as the speed of



the battlefield–in both, seconds do count. Industry also suffers from its own version of the "fog of war."

NIMA's primacy as the market driver will not decline immediately. NIMA will, however, continue to lose its dominance in direct relation to the speed with which the opposing market forces increase. If NIMA does not maintain its position as being the driving force of the market, NIMA will not be able to continue to lead and direct the technological advances in both tools and sources that support its mission. In short, NIMA has to realize that it is in a market that is growing more and more competitive everyday.

The fundamental question to NIMA's survival is whether it can change the way it works in order to take advantage quickly of developments from the mainstream commercial sector–here defined as being those private sector industries that are more driven by the commercial marketplace than by direct government funding. Also, NIMA must deploy analytical systems that allow its customers to directly give NIMA new ideas regarding the technology and services that NIMA deploys–this is key for NIMA to remain a premier intelligence provider.

All the documents presented to the Commission and all the people who have spoken before the Commission have stated that innovation is the key to NIMA's future. Unfortunately, NIMA is holding onto legacy business processes that do not provide it with the flexibility necessary to adapt. This is understandable, since the changes NIMA needs to make are against its existing business model, which is based on the business practices and technology that have sustained NIMA so far.

NIMA, however, has to "commercialize" itself. It has to adopt the disruptive business models of the "dot-com" world in order to move at the speed of innovation. In short, NIMA must evolve or die.

In the text, *BEST TRUTH: Intelligence in the Information Age*, the authors write that the most remarkable aspect of the information revolution is not the technology itself, but the ways by which information is "managed, produced, and consumed." The continuation of the revolution is not a centralized affair; rather, it is highly decentralized, in that the users of the information now have at their disposal the ability to envision, design, build and deploy

systems based on commercially available tools. This is anathema to the centralized, hierarchical acquisition model upon which most organizations have thrived for decades. NIMA must realize that if it is to indeed *define* the information edge, it cannot centrally change itself based on a schedule; rather, it must push the tools for change down to the user. NIMA must give the customers of NIMA's materials the tools they need to innovate.

One of the major reasons for NIMA needing to push the innovation down to the desktop of the individual analyst is that the post-Cold War intelligence mission has become more *ad hoc* and chaotic than before. NIMA can counter this nonlinear mission by allowing the users of NIMA's tools and sources to give NIMA the ability to "self-organize"–that is, to dynamically adapt NIMA to changing mission needs. This, however, requires an architecture that allows the users to develop and adopt their own tools within a commercially viable hardware and software platform. This flexibility is only possible outside a traditional, centralized approach to system development and acquisition.

NIMA can take a lesson from a commercial giant, General Electric, and its race with Bell Laboratories to invent the transistor, which is recalled in Lester Thurow's article, "Brainpower and the Future of Capitalism." Bell Laboratories developed the transistor exactly one day prior to General Electric. The reason for this delay was that General Electric gave the job of testing the transistor to its vacuum tube engineers. The vacuum tube engineers spent three years trying to prove that the transistor would not work. Bell Laboratories, on the other hand, spent its time trying to prove that the transistor would work. As Thurow so clearly puts it, "There were five companies in America that made vacuum tubes and not a single one of them ever successfully made transistors or semiconductor chips. They could not adjust to the new realities." If GE had spun off a new company based solely upon the viability of the transistor, then GE would now have all the patents and Nobel prizes and revenues from the transistor. More importantly, GE would also have been in a better position to benefit from the revolution in miniaturization that marked the introduction of the transistor. Instead, GE ended up having to buy transistors and semiconductors from various suppliers.

NIMA will have to recognize *its* new realities, and adjust accordingly, since, unlike a commercial venture, NIMA will never go out of business–NIMA's business (the generation

of intelligence), however, will suffer if NIMA cannot adopt these disruptive business practices. NIMA will have to set up its own in-house competitors, whose only charter is to "break the old to make the new." Nothing should be sacred to this group–neither process nor product. In this way, NIMA will not run the risk of asking people with conflicting interests to generate new ideas.

Another example which focuses more on the generation of intelligence from a consumer's perspective is also helpful. Recently, Walker White, Chief Technologist of Oracle, recalled a business decision he made while waiting for a flight at SFO. The airline representative told him that his flight would indeed be arriving shortly and that his flight would indeed depart on time. Walker accessed the Internet via his Web-enabled digital phone, went to *www.thetrip.com*, loaded his flight information, and found that his plane had left LAX, was traveling at 25,000 ft., was cruising at 400 knots, and was headed south. Walker states that even he can figure out that the flight will not be arriving "soon," and will definitely not be departing "on time." Walker then goes to a competing airline, exchanges his ticket, and arrives home a little later than planned but not as late had he stayed with his original itinerary.

NIMA has to understand that the Web is going to be its future, regardless of what NIMA would like to do. Otherwise, it will be in the position of being a misinformed airline representative trying to convey an incorrect explanation to a more knowledgeable customer. Everyone must utilize Web-based technology, since all vendors are building Web-enabled tools. The Web is now unavoidable, which means that businesses are moving to the Web and vendors are building the tools that allow the businesses to move.

The increase in capability and capacity in both hardware and software, NIMA's customers are in the position of being Walker White–except for the fact that NIMA owns the source material. NIMA's customers do not have to wait for NIMA to execute a grand design of a system; they can–and do–cobble together systems that can exploit NIMA's source materials. White knew that the airline representative was either lying or misinformed. NIMA's customers know that NIMA is either a well intentioned yet bloated bureaucracy or an organization that is out of touch with its customers or both.

NIMA can correct this, because NIMA has allowed it to happen by abdicating its oversight authority of its contractor base. Thus, the contractors will be true to their in-house knowledge and business plans and will deliver a product that best meets the needs of both NIMA and the contractor's stockholders.

10.4 Commercial Imagery Providers

NIMA has the statutory and logical responsibility for "buying" all commercial imagery (and geospatial products). NIMA has graciously interpreted this to mean that it is to facilitate the transactions and assure that, if required, the content (intellectual property) can be shared across the relevant national security community. And at least in an early prototype, NIMA chose the online "Mall" model that we see with commerce on the public Internet.[22]

The Congress showed keen insight in designating NIMA the DoD and Intelligence Community sole focal point for commercial imagery. Not to be outdone by itself, however, the Congress, one year, denied NIMA the funds necessary for purchasing that imagery. The administration topped that, in successive years, by failing to request sufficient funds, a move that the Congress then trumped by authorizing and appropriating funds that were not requested. Most recently, the NRO announced an on-again, off-again, Billion Dollar Buy. The Commission observes this hot-potato approach with wry amusement; if it weren't serious it would be funny.

NIMA has, rightly, assumed responsibility for provisioning the Library/Warehouse with data, including commercially obtained products. Rightly, too, it has decided that it can franchise to those commercial interests the job of vending products directly in the Library/Warehouse/Mall. NIMA's job should be to ensure that the shelves are full of quality stock. There should be an "archive manager" whose job it is to evaluate and grow the value of the holdings, including the ability to order imagery "on spec." Users should be empowered to make their own ordering decisions. In order to keep the transaction costs

[22] The implementation, as we understand it, is on a protected "intranet" or "Virtual Private Network" (VPN), which provides some operational security and duly diligent protection of the intellectual property rights of the vendors. If need be, the information can be replicated onto an intranet at the SECRET level from the unclassified, Official Use Only, level.

low, the actual cash stash—duly requested by the Administration, appropriated by the Congress, and preserved in the Office of the Secretary of Defense—could be administered by NIMA for OSD. This commercial imagery fund should be the vehicle for end-users to buy both raw imagery and vendor's value-added offerings. The Commission estimates that, for the first year, $350 million seems about right; based on what the Commission expects to be a positive experience, that number should be expected to rise substantially throughout the FYDP. Note that this suggested amount for end-user purchases is exclusive of traditional outsourcing of NIMA legacy products, *e.g.*, maps.

In the FIA, the question of commercial imagery is to be addressed, but too late[23] and, it appears, with a less-open model.[24] What is sorely needed is a policy review and coherent strategic direction for the use of (and reliance upon) commercial products. When planning FIA, consideration was given to the then-current generation of commercial imagery, which did not significantly change the equation. The FIA planning "error" was in failing to realize that a commercial generation was half as long as a government generation. In retrospect, FIA planners might better have bet on the come, anticipating the commercial imagery that would become available contemporaneously with FIA. This likely would have changed the equation and permitted FIA to move "upscale"—move its sensors to a higher technological plateau, to include, say, HSI—and, in the event, be more complementary and less competitive with commercial imagery.

10.4.1 NIMA's Commercial Imagery Strategy

NIMA engages the commercial imagery industry as a user of commercial imagery in support of its own missions; as the central purchasing agent for the DoD and Intelligence Community; as the agency responsible for the tasking, processing, exploitation, and dissemination of commercial imagery; and as a contributor to the policy processes by which the government regulates the commercial imagery industry.

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[23] The ASD/C3I has a good, if leisurely, plan to address commercial (and airborne) imagery in later phases of FIA.

As the functional imagery manager, NIMA should advocate commercial imagery, especially where it satisfies a unique need and/or offers unclassified information-sharing opportunities. In 1998 NIMA and NRO developed a commercial imagery strategy to take advantage of the emerging US commercial imagery industry. Included in this strategy was a provision for the "unambiguous commitment" to commercial products and services. The strategy was rolled out, publicly, signaling a new approach to commercial imagery by the US government with important implications for its overall imagery architecture.

Yet, implementation of this strategy remains unfulfilled.[25] Areas of concern to the Commission include:

Strategy and philosophy: NIMA has been slow to adopt commercial imagery, although trend lines are improving. Until recently, NIMA had a poor understanding of how commercial imagery could meet existing or future imagery requirements. NIMA has failed to elaborate on the relationships between classified imagery information and commercial imagery, whether in terms of real cost or comparative advantage in using either one. Moreover, NIMA still tends to consider raw imagery as the sole commodity to be acquired from industry rather than value-added products and services, including imagery analysis.

Coordination of Commercial Imagery Purchases: NIMA gets mixed reviews on its role as the central coordinator of commercial imagery purchases for the Department of Defense and the Intelligence Community, especially from field elements. While NIMA's licensing agreements provide a discounted price to the US government, as well as a central repository for imagery, current DoD and other users of commercial imagery do not understand the process.

People: NIMA's Commercial Imagery Program has suffered a high turnover of personnel during its early years. The Commission believes that a senior officer must

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[24] At issue is whether the vendors of commercial imagery have the opportunity to interact with, and "drop ship" their wares directly to, end-users, primarily on an unclassified (SBU) network, or whether their products will immediately be scarfed up into a classified network, thereby isolating them from users, for the most part.

have responsibility for this position. NIMA has made little progress in refining their and their customers' understanding of the real costs associated with imagery.

Funding: Insufficient funding imperils implementation of the Commercial Imagery Strategy. The funding levels envisioned in the current strategy appear small, given the potential payoff to the nation.

Architecture: While NIMA correctly envisions seamless tasking, processing, exploitation, and dissemination of commercial imagery, it has by necessity developed a separate architecture to handle commercial products. NIMA should accelerate its plans to integrate commercial imagery products into the FIA MIND.

Acquisition model for commercial imagery: NIMA continues to think about the commercial imagery industry predominantly as a source of raw imagery, rather than as a provider of a more varied slate of products and services.

NIMA also plays an important role in the US policy and regulatory processes related to commercial imagery, including licensing. While the Commission believes that NIMA has played a more supportive role than other Department of Defense and IC agencies, it should continue to play a stronger advocacy role for commercialization, especially in light of strong consumer demand.

Finally, while the Commission believes that a shift may be occurring within NIMA with regard to commercial imagery, it is a shift that is neither fast enough nor done with sufficient conviction. Remote sensing commercialization is taking place within a broader US national strategy that NIMA has not yet seen fit to fully endorse or encourage.

10.5 Commercial Value-Added (GIS) Product Suppliers

NIMA needs to view the commercial imagery industry as more than just a source of imagery. The commercial sector can provide some of NIMA's imagery analysis services and most value-added geospatial products that can meet most, if not all, of NIMA's requirements.

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[25] This despite the on-again, off-again, Billion Dollar Buy of commercial imagery announced by D/NRO.

There is a long tradition of nongovernment mapping activities, and there has always been considerable commercial capacity to produce such products. Although a lot of that capacity was embodied in small, "mom and pop" shops, there was a lot of vitality and innovation. The current plentitude of shrink-wrapped GIS software is a testimony to the vigor of the commercial industry. Most recently, the industry has been undergoing some restructuring on its own and also in anticipation of NIMA needs. There is both horizontal and vertical integration. Most notably, the commercial imagery providers see their future not in providing commodity imagery, but in selling value-added products and services built upon their imagery offerings. NIMA is seen as an underdeveloped segment of this market, and it is.

10.5.1 NIMA's Buying Habits—Actions Speak Louder Than Words

The Commission lauds NIMA's espoused goal of buying such products from commercial industry. By all accounts, however, the execution of this strategy lags. The temptation is to lay the blame at the feet of institutional resistance to outsourcing, which naturally stems from internal job satisfaction and a feeling that they can do it better, as well as a modicum of job protection, *per se*. Some Commissioners observed that the NIMA processes for ensuring quality (QA/QC) may be influenced unduly by workforce protectionist instincts rather than real quality control concerns. Another chokehold that NIMA can exert is the failure to provide source data/imagery in timely fashion. As mentioned elsewhere, the coming availability of high-quality commercial imagery should alter this equation: classification is no longer a valid excuse for delay and the product suppliers can, themselves, contract for source materials without depending upon Government Furnished "Equipment" (GFE).

There appears to be a tendency on the part of some in NIMA to view its GIS vendors as simply a "body shop"—a *de facto* supplement to its workforce. This handicaps the contracting officers, stifles vendor creativity *vis a vis* higher value-added products, and means that NIMA generally is perceived as a poor business partner.

There are, however, many in NIMA who are to be commended on their commitment to get the in-house/outsourced balance correct. The Commission was particularly impressed by those in NIMA who are exploring the diversity of outsourcing methods.

10.5.2 A Strained Relationship with Industry

The Commission was treated to a gentle, but ubiquitous perception–held by contractors and vendors—that NIMA was not a good, dependable business partner. In part, this perception is held by contractors about all government agencies with which they do business and/or would like to do more business. The US government arrogates to itself some unique business notions: its contracts call for "termination for convenience," the government's convenience, that is. The year-to-year funding of government agencies reflects itself in language that conditions long-term commitments on "the availability of funds" and leads to a "hand-to-mouth" existence for some suppliers for whom the government is the major customer.

Beyond the ordinary, however, NIMA has been characterized as an unreliable partner. NIMA-specific complaints are due partly to NIMA's own penurious state, the growth of its mission, and the relentless march of technology that injected early obsolescence into last year's plans. And perhaps subtle sabotage springs silently and unbidden—sometimes unconsciously—to the minds of workers forced to confront outsourcing many of their "birthright" jobs. Notwithstanding, NIMA can and must establish a better relationship with its commercial suppliers.

Among the compelling reasons for burnishing its image with its commercial suppliers is that as commercial imagery and derived applications take off in the commercial sector, NIMA's own position as a favored customer is marginalized. This has happened before, especially in the information technologies, which is where NIMA is largely positioned.

One positive step that NIMA must take is to ensure that its staff, and especially its contracting corps, understands better the business of business. The Director of NIMA is to be commended for convening an industry forum in which NIMA talks *and listens.*

11. NIMA Management Challenges

At the highest level, the Director of NIMA operates under two sometime-handicaps. The first is the ambiguity of whether, or when, he works for the DCI or the SECDEF. The second is his relatively short tenure.

11.1 The Role of the DCI Versus SECDEF

While the DCI and SECDEF have ultimate common purpose, their missions are distinct, their methods disparate, and their day-to-day priorities not always congruent. In drafting the National Security Act of 1947, arguments were advanced as to the desirability of placing foreign intelligence within the Defense Department, under the Joint Chiefs of Staff. The decision to form an independent agency, CIA, headed by an independent director reflected the desire for independent intelligence in support of national security policy decisions.

From its inception, the Central Intelligence Agency has held some sway over strategic reconnaissance—from the U2, to the SR-71, to imagery satellites—and the Director of Central Intelligence had been the developer of strategic reconnaissance assets and arbiter of how the resources would be used.[26] Times change, of course. The SR-71 was retired, and the U2s transitioned from national to theater assets. Imagery satellite tasking, however, has been retained under the thumb of the DCI, *at least in the absence of major hostility*. There is a relatively recent agreement between the DCI and the SECDEF, generally referred to as the *Transfer of Tasking Authority*, which provides for final adjudication to transition to defense under "wartime" conditions, or when the President so directs.

11.2 The Tenure of the Director of NIMA

The Commission finds that the present tour length of a Director of NIMA, two to three years, is insufficient to complete execution of the plans and programs of this young

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[26] This was not accidental, but a deliberate decision of then-President Dwight D. Eisenhower, anxious to see "civilian competition to the military," a situation that has prevailed, *de facto*, until the present. It has, however,

organization. Institutionalizing change is never easy as there frequently is subtle resistance among subordinate levels of management. A longer tour reduces the opportunity for those subtle resistors to simply outlast the Director. Nor is this problem unique to NIMA. The National Security Agency, going through a rebirth, is said to be similarly afflicted.

The answer is simple. Having chosen the right person to lead the organization, his/her length of tour must be established at the outset as, say, five years. This should allow for a reasonable chance to fully carry out and institutionalize needed changes without being impelled to embark prematurely on changes before taking sufficient time, at the onset of the tour, to understand the organization, or to run the risk of running out of time.

As with NSA, the (shorter) history of NIMA is to be led by a general officer nominated by a military service, concurred in by the DCI, and appointed by the SECDEF. For a senior flag officer, Congress, too, has a say. It may be that the uniformed military are unwilling to commit to so long a tour for a senior flag officer because of a "star" problem—a problem that Congress could, in fact, solve. Alternatively, civilian leadership should be considered with a military officer as deputy. Whatever the solution, the objective is to ensure better continuity and sustain the momentum.

11.3 The Job of Director, NIMA

Being Director of NIMA is not easy. Defining the job of the Director of NIMA is not so easy, either. Is he the principal (substantive) imagery intelligence officer? Or, is he an information factory manager? This ambiguity simply mirrors the bifurcation in NIMA's mission.

Externally, D/NIMA seeks to serve (at least) two masters, the Director of Central Intelligence and the Secretary of Defense. Fortunately, there is considerable congruence in their missions. Unfortunately, there are some differences. Internally, the Director of NIMA tries to harness two cultures, in two cities. His two principal product lines, imagery intelligence and maps, have two distinctly different clienteles. Imagery intelligence has its

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been eroded by the change in U2 status, and the *Transfer of Tasking Memorandum* that provides for a change in final adjudication from the DCI to the SECDEF under "wartime" conditions or when the President so directs.

number one customer in the White House; maps have their number one customer in the foxhole.

His mission increasingly depends on technology, but his workforce is grounded more in the liberal arts. He is underresourced and cannot depend wholly on his upper-management corps. His fount of expertise is being drained by retirements and by those who would rather return to their CIA roots than take the DOD pledge.

11.4 Authorities of the Director of NIMA

The Director of NIMA said, and the Commission agrees, that he currently has sufficient authorities with which to execute his responsibilities.

The Commission does observe that D/NIMA has been deliberate about the exercise of his responsibilities as functional imagery manager, presumably constrained by real resource limitations and a realistic concern about shocking the system. Notwithstanding, the Commission suggests gently that D/NIMA signal his intent to incrementally increase his forcefulness in order to achieve more quickly his strategic objectives.

DOD Directive 5105.6 specifically identifies D/NIMA as the functional manager for imagery, imagery intelligence, and geospatial investment activities for all budget categories—the National Foreign Intelligence Program, the Joint Military Intelligence Program, and most important the Tactical Intelligence and Related Activities.

The D/NIMA can and does provide guidance to the IMINT community to ensure that investments are in line with the USIGS framework. While the D/NIMA can control investments in his own agency, his influence on his mission partner, the NRO is problematic and he has next-to-no *de jure* influence over investments made by the Services, which have their own appropriations and authorizations in the TIARA Program.

Others have tried to harness the NRO and the Services and failed. Still, the Commission wonders if there couldn't be an effective approval process which ensures that *all* IMINT investments comply with guidance from the functional imagery manager, D/NIMA.

11.5 D/NIMA Span of Control

Some among the Commission believe that the span of control of the Director of NIMA is too broad and would recommend reorganization. Sometimes—particularly in a young or untested organization—the apparent solution to every problem is a dedicated manager or senior staff officer with a "direct report" to the top. Usually, this indicates that the overall business model of the organization has yet to gel.

The Commission has no concrete examples to indicate that the current Director is spread too thin and that some important matters have suffered from a lack of his attention. Indeed, the Commission is impressed by the overall effectiveness of the current Director and his senior leadership team, considering the stresses to which this tender organization is exposed.

If there is a legitimate concern, it is not with the present operation, but with the need to establish tomorrow's leadership, which generally involves more, rather than less, delegated authority.

11.6 NIMA Culture(s)

Two sets of forebears, two legacies, two missions, two cultures. Can the promise of NIMA—to take advantage of the technical convergence between imagery and mapping in the digital age—be fulfilled without an overarching culture? The Commission suspects not.

Each culture perceives the other as failing to understand its specialty, and each (but especially imagery analysts) feels disadvantaged by having to work for a manager of the opposite persuasion. Both worry that convergence will turn all the princes into frogs, rather than the frogs into princes. The Commission believes that nothing could be further from the truth: enlisting all the NIMA disciplines in a single mission, uniting the workforce, and melding the cultures will enhance the effectiveness of each.

NIMA management has been justifiably cautious about espousing convergence as the goal and forcing the respective cultures to confront head-on the issues that separate them. NIMA management appears to be genuinely conflicted, both about the worthiness of the goal—witness the bifurcated mission statement—and about whether the pain will be worth the gain, which is understandable, if regrettable.

It is all too easy for outsiders to be impatient with the progress and therefore critical of NIMA management, and the Commission is uneasy in urging greater haste. It is possible that the inevitable just takes a little longer, that familiarity breeds admiration rather than contempt, and that the organization is still too fragile and the stakes too high to press harder.

The Director of NIMA seems genuinely committed to the desirability and eventuality of greater synergy, if not outright fusion, of the two disciplines, and is working to instill this commitment in his senior managers, many of whom already "get it." With perseverance, this will percolate through management layers, as well as bubble up from the working level where the synergies are sometimes more evident. The Commission hopes that there will be time for this approach to work.

The Commission believes that WorkForce-21 offers an opportunity to reward tangibly those individuals who seek, master, and constructively employ, both kinds of skills. Promotion and compensation, as well as official recognition, are the incentives that management can use to motivate desired behavior, and WorkForce-21 potentiates these management tools.

The Commission also believes that internal connectivity, training, and facilities all need to be improved with an eye toward overcoming cultural barriers.

11.7 WorkForce-21

Change is always unsettling to the majority of a workforce, and NIMA is no exception. Change highlights the fact that one worker's opportunity is another's peril. The NIMA workforce needs to understand which performance metrics embody leadership's expectations and are considered critical to the overall success of the organization. WorkForce-21, if executed properly, holds out the promise of ensuring this.

WorkForce-21 moves away from what some have considered the overly paternal civil service model and toward heightened individual accountability for one's performance and one's career development. The pillars of WorkForce-21 are enunciated, incentivized expectations and reward for individual initiative.

Within the NIMA workforce, the Commission found some serious concern about the organization's Key Component leadership reflected in an employee survey conducted after WorkForce-21 had been initiated. Many of those interviewed, both in the survey and by the Commission, believe there is an absence of robust Key Component leadership; some also feel that existing authority is too centralized. WorkForce-21 attempts to reduce the inimical influence of old-style management's old-boy/girl network. The success of WorkForce-21 will depend on middle management, which, after all, must translate the vision of superiors into workaday instructions for subordinates.

The Commission cannot help but remark that NIMA, like many government agencies, and quite distinct from good business practice, seems, *de facto*, to have used its workforce downsizing as an opportunity to reduce, rather than improve quality—only in the government!

11.8 SES/SIS Billets

NIMA requires an increasingly technical and skilled workforce and exceptional leaders to help it usher in the FIA area. NIMA is disadvantaged by the small number of SES/SIS billets it currently has—about half the overall government average, and many fewer, *per capita*, than its sister intelligence agencies. The Commission considers it unlikely that it can find and retain the caliber of officer it needs and deserves unless the roster of SES/SIS positions can be ameliorated.

The Commission recommends an increase in SES/SIS billets in its primary mission areas, imagery analysis, and geospatial information services. And while such "supergrade" positions would also benefit the systems engineering and acquisition activity, the Commission urges that consideration be given to creation of an "Extraordinary Program Office" (EPO) with rank and pay scale "outside the system" as detailed subsequently.

11.9 Workforce Expertise

The Commission sees some evidence that NIMA's progress as an effective and efficient organization is constrained by insufficient and inexperienced staff in some critical areas. In addition to the previously remarked upon shortages of highly experienced imagery analysts

and systems engineering and acquisition staff, NIMA is light in unique areas like imagery science.

11.9.1 Imagery Analysts

The Commission observes that the decline in experience and expertise in NIMA's Imagery Analyst corps has seriously impaired NIMA's ability to support its customers. Not limited to NIMA, as the Commission notes, the downturn in analytical expertise is due to both loss of experienced people and the fewer lessened number of years of experience held by the new hires. NIMA's imagery analyst workforce has declined, on average, from 13 years of experience to 11 years of experience, and 40 percent of the imagery analysts have less than 2 years of experience. This situation leads to more experienced personnel having to devote more time and effort to both training and mentoring, and consequently less time to supporting NIMA's customers.

11.9.2 Imagery Scientists

The term "imagery scientist" can be subject to multiple interpretations.

> One might conjure up the image of a scientist who worried about the chemistry of films, emulsions, photo-sensitive materials, and D-log(E) plots or the electronic-age equivalent who worries about CCD-arrays, spectral sensitivities, density functions, gamma corrections, orthorectification, *etc.*—*i.e.*, the "science of imaging."
>
> Alternatively, one might think of a scientist who understands the phenomenology of a problem and its imagery observables—how the hyperspectral "image" information might distinguish between an emissive cloud of toxic nerve gas and the benign effluent from a baby milk factory; or how the thermal infrared image distinguished between a real SU-27 and a plywood decoy on the tarmac.

Clearly, the imagery intelligence business needs both, and the cartography business benefits from the first, if not the second.

However, as understood by the Commission, it is the second interpretation that underpins the assertion that the Intelligence Community has a paucity of "imagery scientists." It is the science-based exploitation of the image that must be nurtured by NIMA.[27] The question is whether NIMA can have such scientists in-house—*i.e.*, as USG employees—or must look to industry, academia, and the national labs for such expertise. The Commission suspects the latter is the case: NIMA would find it hard to accommodate the number of diverse scientists required, could not support their professional development or advancement, and would otherwise have trouble attracting and keeping them. Better to rely on extant "centers of excellence" and, in their absence, to stimulate such centers.

The Commission agrees that there is a shortfall in "imagery scientists" so defined. In fact, the Commission notes the broader shortfall in the Intelligence Community of sound "targeting"—*i.e.*, understanding the "business processes" of the target, modeling and simulating these, and mapping them to infrastructure, all of which then suggests the set of observables, against which multi-INT collection can be launched and upon which all-source analysis can be based. There is realization, in the Intelligence Community of the desirability of better targeting and examples of innovative targeting—*e.g.*, by the "issue managers" and on their behalf by the ADCI/C-sponsored Collection Concepts Development Center (CCDC). The NRO, too, often sponsors early science-based work in support of new collector concepts.

For NIMA, the Commission concurs in reliance on external sources of expertise for such science-based problems insofar as NIMA cannot, itself, attract and retain such skills.

11.9.3 Engineering/Acquisition Expertise

NIMA lacks the sufficient expertise in systems engineering/systems integration and acquisition sufficient to carry out an efficient and effective large modernization program. The Commission believes this situation must be rectified in order to successfully implement the USIGS program and the Commercial Imagery Strategy. The Commission believes that

[27] The vibrancy of the commercial photo market, both film and digital, guarantees that there will be no shortage of expertise dealing with the science of imaging.

NIMA needs to bolster its staff in this critical area and that it cannot do this, in time, "within the system." It recommends, therefore, that NIMA create—as described in detail elsewhere—an "Extraordinary Program Office" (EPO) with the active help of the DCI, SECDEF, and Congress.

11.10 NIMA Management

Management, in any organization, is a critical and often weak link in the chain. NIMA, in its time of change, absolutely must rely on management, especially those seniors who report to the Director. Change, whether inspired by vision from the top, or insights from the bottom up, always confronts its highest hurdle at this level. NIMA does have many qualified executives and managers; it just needs to ensure that all its management corps can pass the test.

11.11 NIMA Resources

The Commission finds little disagreement as to the fact that NIMA is severely under resourced given the expanding mission and the need to modernize USIGS in light of FIA. Not surprisingly, there is considerable disagreement as to the fount from which the needed resources should spring, and incessant caviling about whether NIMA, as currently constituted, is capable of efficiently executing the funds that it surely requires.

The Commission finds little logic in the argument that, although they need the money, they are not yet capable of spending it wisely and so can make do with less. Try as it might, the Commission cannot think of an instance where an inadequate organization can do the job more cheaply than a first-rate organization. And the job has to be done.

The answer, of course, is to provide the resources and support NIMA's becoming the first-rate organization it needs to be. Elsewhere, the Commission recommends creation of an "Extraordinary Program Office" (EPO) with world-class talent whom none could gainsay. Staffed and armed with the authorities recommended by the Commission, the EPO will surely reduce the cost of the overall program. Still, the current budget (POM/IPOM) will need to be fattened considerably to realize fully the promise of FIA and USIGS. Get used to it.

In retrospect, the Commission opines that had the stand-up of NIMA included a more rigorous analysis of the true costs of programs and projects to be undertaken by NIMA, the DCI and SECDEF might have avoided the past four years of acrimonious budget debates.

NIMA's first budget (FY 1997)—far from the result of careful, deliberate analysis of all the functions and missions assigned to it—was the agglomeration of projects and programs inherited from the CIA, DIA, NPIC, DMA, NRO, *et al.* Since 1997 NIMA has consistently requested and received "over-guidance" funds. Each year since its stand-up, funding for NIMA programs has been a major issue for out-of-cycle budget deliberations. As a result of increases in the President's budget and yet further additions by Congress, NIMA's resources have grown faster than any other program in the IC.

This year NIMA received an increase billed as a "down payment" for TPED. Taken literally, there is hope that NIMA's budget line will increase over the next three years to a point where it can discharge its responsibilities fully. Only upon "payment in full" can the true expectations of NIMA, set back in 1996, be achieved.

On a smaller scale, the Commission observes that NIMA faces a situation of insufficient resource support for its internal infrastructure. In briefing after briefing, the Commission was told, by supporter and detractor alike, that the NIMA infrastructure was not up to the present mission, much less the future. On the positive side, the Commission commends NIMA's plans for consolidation of certain facilities, and lauds progress to date.

12. NIMA's Information Systems—TPED At Last!

For the military, decisive force, power projection, overseas presence, and strategic agility will be the strategic concepts to meet the challenges of the future. As first explained in *Joint Vision 2010*, today's military capabilities must transition to dominant maneuver, precision engagement, focused logistics, and full-dimensional protection. The evolution of these elements over the next two decades will be strongly influenced, first and foremost, by the continued development and proliferation of information technologies. Information superiority is the key enabler.

Information superiority—knowing more than enough about an adversary who knows much less than enough—is the key enabler for the practitioners of US diplomatic and economic policy, as well. Geospatial information is nearly always the key to an international engagement, whether on the grand strategic level or at the "tactical" level of flesh and blood and mud. From international borders to artillery aim points, from the flow of goods and services to the mobility of a tank, geospatial information paves the way and points out the opportunities.

Moreover, with the advent of commercially available, high-resolution (less than 1-meter) satellite imagery, the United States has lost the exclusivity it once had. These images will be available, as never before, to any potential adversary. While it may be regrettable, it is not possible (nor even desirable, on other grounds) to turn back the clock. The US answer must be to use its still considerable advantage faster and better. To state the obvious, imagery TPED, in all its dimensions, is the key to "faster and better." Our use of imagery and imagery-derived intelligence must put us "inside the adversary's decision cycle." The importance of TPED for information dominance cannot be overstated.

Everyone agrees that imagery TPED is critical for information dominance; not everyone agrees on just what TPED is!

12.1 Defining "TPED"

Literally, "TPED" is an intelligence insider's acronym that stands for "tasking, processing, exploitation and dissemination" and is usually juxtaposed to a specific intelligence collection discipline—*e.g.*, imagery, SIGINT, etc.—or to a specific intelligence collection asset. Thus, we speak of "tasking" an imagery reconnaissance satellite, "processing" its raw collection, "exploiting" its processed collection take, and "disseminating" the resultant information products. Such a recitation, however, may lead one to conclude that TPED is a neat, serial process. It is not.[28]

Nor is TPED a system. There is no single set of engineering specifications, nor will there be. There is no single systems architecture, in the strictest sense. By some lights TPED is a "system of systems" but even that construct is misleading. TPED does embrace a concept of operations from which one may infer certain architectural concepts and, looking to the future, one can substitute newer architectural concepts and modify—hopefully improve—TPED.

Some have suggested that we view TPED as the (real-time) supply-chain management for the Imagery and Geospatial Community (IGC).

Alternatively, think of TPED as shorthand for the ensemble of (people,) systems, and processes that add value to an intelligence collection system. This construct is especially

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[28] Some have suggested that the literal definition of imagery TPED is an anachronism and needlessly constrains our thinking. Alternative constructs are proposed:

Gathering versus Tasking –"Tasking," it is argued, stems from a model based on scarcity, where the collector is limited. "Gathering" is a more useful term, deriving from a model based on abundance where discovery is the issue.

Creation versus Processing—where a multisensor view of information is contrasted with a single-sensor view of data formation.

Analysis versus Exploitation—"Exploitation," it is argued, is an overly narrow Indications-and-Warning (I&W) view of imagery; "Analysis," by contrast, is the function people perform best, seeing patterns in information.

Sharing versus Dissemination—where "sharing" is a many-to-many model of information communication, while "dissemination" is a one-to-one, or one-to-many model of data movement.

TPED, they argue, is derogated as needlessly implying a linear view of data. The alternative formulation—Gathering, Creation, Analysis, and Sharing (GCAS)—is billed as a cyclic view of information.

useful insofar as it leads us to question whether a collection system by itself—no matter how technically elegant—is of value commensurate with its cost. The construct also allows us to consider separate elements of TPED functionality and ask, too, whether the value each adds justifies its respective cost.

12.1.1 Tasking

Tasking is the value-adding process by which we try to ensure that the right image gets taken, at the right time. If collection capacity is a scarce resource, then tasking includes the optimization of that scarcity. Today—and, arguably for the indefinite future—technical insight into specific collection systems is necessary to accomplish good tasking. Consequently, a corps of trained intermediaries—who mediate between the information needs of intelligence consumers (as well as all-source analysts) and the tasking of collection systems—are, and will remain, a necessary fixture in the TPED process. Despite the intermediation, we must maintain a thread to those whose needs initiated the tasking and provide feedback—ideally with a predictive component—to the end-users as to the status of a request.

12.1.2 Processing

Processing is the automated, rote application of algorithms that transform raw collection take into a product better suited for exploitation by a diverse set of analysts and for a diverse set of purposes. There is a continuum between collection, processing, and exploitation. The collector can have embedded and/or "on-board" processing. Or processing can be at a "down-link" site. In any case, there usually are heavy computing demands and consequent economies of scale in processing, as well as a requirement for intimate technical knowledge of the collector. For these reasons, processing is more closely tied to collection than to exploitation, both in systems design and organizational responsibility.

Because the processing "system" has as its input a well-defined collection system specification, and because it controls explicitly its output specifications, it is arguably the easiest function of TPED to architect. Said differently, it largely is isolated from the vagaries of human interaction—"free will" being the archenemy of system architecture. There is a

valid interest in migrating "upstream" into the processing segment those exploitation tasks that can be routinized and automated. This complicates only slightly the processing system architecture.

We might think of processing as the link in the chain that transforms "data" into "information" accessible to human analysts.

12.1.3 Exploitation

"Exploitation" is the most abstract of the concepts and, perhaps for that reason, the easiest of the TPED functions to define. Exploitation comprises all those value-adding activities that transform imagery into intelligence or, more generally, the link in the chain that transforms "information" into "knowledge."

Because there are still an infinite number and variety of exploitation algorithms yet to be discovered, one is challenged to devise a meaningful exploitation architecture.

12.1.4 Dissemination

Generally, dissemination is thought of, simply, as getting the right information to the right place, at the right time. It is sometimes useful to decompose dissemination into two parts: the physical process of getting it there, "distribution;" and the logical process of deciding "what goes where." Of the two, the distribution historically appears to be the more expensive and difficult, and the most boring. The logical process of dissemination is by far the more intellectually challenging.

12.2 If That's TPED, What is USIGS?

Literally, USIGS stands for the United States Imagery and Geospatial Information System: the extensive network of systems used by the Department of Defense (DoD) and the Intelligence Community that share and exploit imagery, imagery intelligence, and geospatial information. These systems provide capabilities involved with the integrated management, collection, production, exploitation, dissemination and archive, and infrastructure of this information. Organizations that have some level of interface with USIGS, but are not part

of DoD and the Intelligence Community, are considered participants in USIGS if they adhere to the technical and system standards.[29]

USIGS includes organizations, doctrine, standards, procedures, libraries, and hardware/software that collectively provide fused imagery, imagery intelligence, and geospatial information.

The Commission appreciates the Director's reformulation of NIMA as custodian of USIGS. Sometimes misunderstood, this reformulation is emblematic of a healthy change in focus, away from systems, away from products, away from processes, and toward information services.[30]

For this report, however, we persist in using "TPED" in deference to the sensibilities of the reader. In most cases, a simple substitution of "USIGS" for "TPED" or *vice versa* works. Thus, TPED acquisition is equated to USIGS modernization, for the most part—*i.e.*, except for purposes of budgetary and programmatic continuity, perhaps.

12.3 The Scope of TPED—Why Does It Cost So Much?

TPED is truly a global enterprise that includes multiple suppliers (collectors), operating in different environments, and requiring significant supporting infrastructure. NIMA has (at times) described TPED as a system of systems that will provide the tasking, processing, exploitation, and information dissemination service for all imagery. This includes imagery collected by (theater) airborne assets and by national technical means (NTM) as well as those services provided by Commercial Imagery entities. Commercial services can range from raw images to value-added products and fully exploited information.

Programmatically, TPED more or less includes all the people, hardware, software, communications and "O&M" for the entire Imagery and Geospatial Community (IGC) from the "national" level down to the theater JTF/component level.

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[29] http://164.214.2.59:80/sandi/arch/products/uaf/uaf-b.pdf.

[30] This is not to say that NIMA will no longer produce its hallmark products: maps and imagery intelligence products. As NIMA focuses on information services, the maps and intelligence reports are by-products—intentionally useful derivatives, but not the essence of NIMA.

The approach taken by NIMA is to fully modernize USIGS/TPED rather than incrementally upgrade individual components as necessary to be compatible with the NTM collectors of the FIA era. This comprehensive approach, which demands significant investment, is the only way to transition quickly to the information-centric architecture, which the Commission endorses.

Costs are proportional to a number of factors; among the big swingers are size of the IGC, size of the images, number of images. Note that if an image improves in resolution, say from 1 meter to ½ meter, the storage required, the bandwidth required, and the processing power required *all* go up by a factor of four if the area covered remains constant. But, of course, the area covered might drive each cost up by another factor of four. If the number of images per day increases by several score, these costs, again, rise proportionately. As the uses of imagery and geospatial information become more widespread, the community of users can double. And of course, multiplying all these numbers together, as we must, results in an answer that is large, impressively large, daunting to some. Such is the price of information dominance.

12.4 Managing TPED "Operations"

One of the challenges to NIMA is how to manage the significant increase in collection capability that will result from (EIS and then) FIA, and from increasing availability and capability of commercial imagers. Ensuring that tasking is assigned to the right collector is particularly challenging as airborne assets are under theater control, and commercial imagery is subject to the various terms and conditions negotiated with the respective vendors. Ensuring timely exploitation in the face of higher volumes and fewer analysts is challenging, as well. Not to mention ensuring timely distribution over communications channels managed by another agency and procured from various commercial sources.

12.5 TPED Acquisition Management

NIMA is not yet well-positioned to acquire TPED (*i.e.*, to modernize USIGS). As a new organization, it did not inherit from its forebears the systems engineering and acquisition personnel and institutional knowledge. This is reflected in lack of a stationary baseline architecture. As we discuss below, growing this competency is particularly difficult in this

economy where the civilian sector easily outbids traditional government organizations for the needed talent; it will require extraordinary measures.

Despite administration neglect, Congress may provide NIMA with the necessary infusion of resources to start innovative TPED architecture work. To take full advantage, NIMA will have to consider innovative TPED "suppliers" beyond traditional aerospace contractors.

NIMA's TPED system is increasingly akin to an information system built for commercial customers by commercial contractors using commercial methods and commercial standards and employing technology to which DoD adds little. True, NIMA's TPED system is not quite identical to anything else (but no sufficiently complex system is without some unique features). It will be huge and girdle the globe, but there are other systems of comparable size (*e.g.*, oil company seismographic records), data complexity (automaker-supplier CAD networks, inventory systems, commercial GIS products, market data warehouses), and reach (many large banks and credit card companies).

Because of the enormous potential for commercial technology, the Commission feels that NIMA should be more an acquiring organization, less a developing organization except in very specific areas such as imagery science. Nor should NIMA take on the role of system integrator. The Commission has not seen evidence that NIMA currently has the expertise or experience to prepare a comprehensive plan to acquire and integrate a system of systems such as TPED. This lack of expertise is exacerbated by the fact that NIMA must migrate a large number of legacy systems while maintaining operations.

As we reemphasize below, the Commission believes that a Technical Advisory Board of outside experts could serve the Director of NIMA well.

12.6 The Role of Commercial Technology

As stated previously, the Commission does not believe NIMA is making maximum effective use of commercial hardware and software. It appears to be depending heavily upon its current processes and products and persists in developing government standards that diverge from emerging commercial standards.

While it is recognized that use of GOTS may appear to be the most cost-effective short-term solution, a coherent strategy is needed which balances the use of COTS, GOTS, and customized hardware/software, recognizes the advantages and disadvantages of COTS and GOTS, and plans for the long term. The long-term view is of particular importance because TPED, and USIGS, must be able to infuse new capabilities and technologies.

In addition, it is becoming evident that future capabilities in TPED will be very dependent upon COTS. The Commission recognizes that use of COTS presents new challenges to the government to be a smart buyer and user. NIMA has not shown that it has the necessary expertise and experience to effectively integrate many COTS products into a large system of systems such as TPED.

The Commission stresses that an important step on the road to realizing fully the benefits of commercial technology will be the use of commercial, rather than government standards.[31] Without standards that interface with the commercial world, it will be very difficult to accommodate future products and NIMA will be maintaining yet another obsolete system.

The rationale for COTS products is obvious: they exist, they work, and they evolve quickly as the marketplace expands. Because development and maintenance costs are amortized over many users, COTS products are usually less expensive to acquire. Buying a COTS product worth hundreds of dollars allows the USG to cash in on sometimes millions of dollars of corporate development. Buying into a solution that someone has already devised means less need for reinvention. Being able to "try before you buy" means less likelihood of error. With a large user base, COTS is more likely to be supported by third-party applications, tools, services, and training. And widely used COTS products mean that NIMA and its users can interoperate more easily with each other, with other developers, and with other geospatial data providers.

Not all COTS products are equal. Ideally, if a COTS product is to be considered it must be able to succeed in—that is, ship in volume to—the commercial marketplace. Even better, it

should have evidenced some staying power already, and had the kinks worked out (*e.g.*, version 3.0 or later).

A recent study performed by Aerospace Corporation[32] indicates that the government has yet to develop an effective acquisition model for commercial technology-especially software. Much has been written about the benefits of COTS technology, however, the government, according to the study, has yet to let go of the outdated acquisition and development cycle models that require customization and duplication. NIMA must discipline itself to avoid following a commercial path for only part of the way, then reverting to blind satisfaction of requirements without performing cost and benefit trade-offs.

Will commercial products provide everything NIMA wants? A good architecture ought to make it easy to know whether a given requirement can be so satisfied. As a guess, commercial database and GIS tools are likely to satisfy a very high percentage of NIMA's requirements out of the box. The percentage of analytic tools (*e.g.*, for modeling and simulation) that are commercially available is likely to be far less. When NIMA has a requirement unsatisfied within COTS, it has three choices besides reinventing the wheel: pay commercial contractors to support certain features in these versions, wait for subsequent versions, or make do without. Paying for additional features should be a seldom-exercised option lest COTS acquire the meaning: customized off-the-shelf (often, additional features have to be rewritten every time a new version of the base software is issued).[33]

12.7 The IDEX Replacement, IEC, Is a Case in Point

The IEC program—a sad story, but with a potentially happy ending—illustrates the value of COTS products. The Commission has met with imagery analysts who expressed

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[31] As mentioned elsewhere, the Commission is partial to the definition, variously attributed to Scott McNealy, of Sun MicroSystems, that "standards" are products that ship in volume.

[32] *COTS-Based Systems: COTS Software Lessons Learned, Recommendations and Conclusions*, Computer Systems Division, The Aerospace Corporation.

[33] The Commission does offer one caution: increasingly, COTS products are marketed *and* produced globally. This means that a critical COTS product might have been produced by, or within easy reach of, a potential adversary. Information assurance should be a Key Performance Parameter of every significant acquisition.

dissatisfaction with IEC—their complaint is that the IEC's effective, smooth "roam rate" is half that of the system it replaces.

The Commission is perplexed that NIMA would approve, fund, and execute a project to replace IDEX II with a design that, from the start, did not meet one of the most critical requirements for imagery analysis. In addition, the Commission has concerns over the large integration efforts to cobble together various software packages, especially where many of these applications are already available as integrated solutions. Addressing those two issues will likely cause both deployment delays in and cost growth of the IEC program. And the Commission is dismayed that cost of, and or delay in, fielding IEC terminals may impel NIMA to consider purchasing additional mechanical light tables. However, the Commission is buoyed by a recent NIMA initiative investigating a low-cost imagery workstation that meets most specifications, including a faster roam rate, and promises to be significantly cheaper, besides. Other agencies are also aware of this situation and are concerned enough to have started their own in-house programs—clearly a step in the wrong direction and a disappointing development.

Of additional concern is the shift in the commercial world away from UNIX and toward Windows for the very functionality of interest to NIMA. To benefit fully from the COTS cycle NIMA must heed tomorrow's trends, which for client workstation is toward Windows-based solutions and away from UNIX. The cost of high-end Windows workstations is half that of UNIX workstations and the power of graphics engines, fueled by the PC gaming market, is doubling every nine months while the price is being halved. WINTEL[34] hardware and software manufacturers are continuously improving bandwidth and memory access to further enhance performance. So, while capable UNIX designs are currently available, inherent design limitations, less capable graphics cards, and less frequent design improvements, put the current IEC design at a distinct disadvantage, which will only increase with time.

[34] Windows operating system on a box with "Intel inside."

The Commission also learned that many of the "electronic light table" applications that are critical for imagery and geospatial analyses are now being designed for the WINTEL. In fact, UNIX applications are likely to be offered only if requested and not as an "out of the box" solution.

The current IDEX replacement program is an example where NIMA has taken its first steps to employ some disruptive techniques in its system acquisition model. The IDEX replacement has actually followed two tracks–the first, a more traditional large-scale system integration program in which NIMA has used one of the usual government contractors as a designer, developer, and integrator of the IDEX replacement system, called IEC. IEC was to be a commercially based system. Following the normal large-scale development process, IEC has an expensive design, development, and maintenance cycle, and does not meet the existing IDEX capability. NIMA allowed the contractor to decide that CORBA would be the basis for all interfaces between all devices and processes–data would be passed and handled via CORBA-based ORBs. While the use of object-oriented programming to allow heterogeneous data types and processes to intercommunicate is laudable, adopting an emerging standard that is not commercially viable is not. The commercial world has looked at CORBA and has not adopted it as a basis for commercial systems development. CORBA compliance requires the use and development of additional software to act as the "glue" between the heterogeneous data types and processes. This "glueware" will be one-of-a-kind software, generated by the contractor, tied to a specific vendor's ORB, which must be maintained *in perpertuo*, thereby defeating the original intent of utilizing CORBA. This "glueware" is necessary if and only if the system requires tight integration to overcome a perceived ineptitude of the user. This tight integration is necessary to keep the user from making mistakes. NIMA's users are not inept–as evidenced by their ability to innovate the marriage between IA and GIS tools–and they should be afforded the flexibility to design by discovery.

In parallel to this effort, NIMA sponsored an in-house team to examine whether a *purely* COTS solution to the IDEX replacement could be found. A WINTEL-based system using COTS that are built to the WINTEL application programming interfaces (APIs) was built and tested. It performed as well as or better than both the original IDEX and the current

IEC. (This is an example of a disruptive business model and is to the credit of NIMA, *assuming* it is implemented.) The COTS-based WINTEL solution should not be viewed as a COTS panacea; rather, it should be viewed as being a successful attempt at leveraging the existing base of commercially viable products to solve NIMA's IDEX replacement problem. Now that NIMA has a solution that is in step with the forces driving the commercial market, it will be able to take advantage of the advances that are being made in graphical technology in support of home entertainment. This will also allow NIMA to take advantage of the Web technology that will make it possible for NIMA to leverage its customer base for innovations that will give it the information edge.

Now that NIMA has taken the first step in disrupting its normal acquisition cycle, it must follow this innovative development with an equally innovative deployment plan. Using grand designs to replace other grand designs is unsound in light of current disruptive business models. NIMA should be applauded for using existing commercial standards and hardware and software in its in-house IEC replacement system; however, the deployment of this system will require NIMA to overcome its usual bureaucratic inertia that has plagued its other efforts in both TPED and USIGS.

This implementation should not be just an integration of the WINTEL architecture into the existing IEC as another software set that requires a coating of glue; rather, it should be a replacement for the existing IEC, the deployment of which should be stopped. An independent review board reporting directly to the current D/NIMA should be convened to analyze the existing WINTEL IDEX replacement system. This board–composed of non-NIMA systems analysts–should report to the current D/NIMA on the viability of the WINTEL architecture as a cost-effective replacement for IDEX.

To NIMA's credit it tasked a team to monitor IEC developments and pursue a simpler, less costly IDEX replacement. This netted a lower-cost imagery workstation, based on Windows 2000 (W2K) that meets almost all of the specifications identified for the IDEX II workstations, including a much faster roam rate than either IDEX or IEC. Initially certain

capabilities[35] were not available but as a testament to commercial ingenuity, these have been addressed and resolved. NIMA plans to evaluate this capability by deploying 30 workstations in a joint production cell. Assuming success, NIMA will face a dilemma: it can continue deploying IEC and offer the W2K option or fully compete the two designs, "winner take all". The Commission favors the latter approach.[36]

Use of commercial alternatives places great emphasis on getting the requirements right at the outset and managing the process smartly. The Commission notes that IEC is merely one segment[37] of the IDEX II Replacement Project (IRP), which is managed via an Integrated Product Team (IPT) whose roles and responsibilities do not appear to be explicit. There does not appear to be a consistent understanding of either how the IPT is organized or the level of commitment expected from the various segments and/or users. This is not a recipe for success, irrespective of the use or misuse of commercial technology.

12.8 Making Commercial TPED Acquisition Work

Several challenges exist in determining to what extent a commercial approach to TPED would work. A well-defined architecture will prove to be the key to well-placed confidence in commercial alternatives. A check list for success in utilizing commercial alternatives would

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[35] For example, mensuration, display of stereo pair data, and the continuous paging of the data from the server environment.

[36] Data on the IEC and W2K workstation that the Commission reviewed or discussed with various contractors show that the WINTEL workstation hardware would be significantly cheaper (costing no more than $25,000) than the UNIX-based IEC (currently priced upwards of $45,000). Clearly NIMA could field a larger number of workstation or recapitalize at a faster pace than it is planning to. The unsettled debate is in the cost of the software for the W2K workstation. The software costs for each IEC workstation is estimated at about $100,000. It is not clear what the software costs on a W2K would be since the current design has very little integration involved (see CORBA discussion on pg. 97). If no other differences exist, clearly, NIMA could save integration costs and benefit from the economies of scale resulting from using the Windows standard.

[37] Each segment is a separately managed contract, but the relationship of these contracts to the integration contract is not clear. The nature of the delays the IDEX II Replacement Project (IRP) is currently experiencing suggests that the roles and responsibilities for integration were not clearly defined or understood. In addition, it appears that the IRP IPT has limited control over the total life cycle costs (TLCC). As a consumer of components managed via other contracts, the IRP is dependent upon decisions of the segment developers for TLCC impacts. Additionally, the operations phase of the total life cycle includes O&M, which is apparently the responsibility of a sister directorate (Information Services). There was no clear indication that members of this organization participate regularly in the IPT.

include: demonstrating the scalability of the COTS systems under consideration; architectural "elegance," which reduces systems complexity, dependent in turn on identification of good architects; an inclusive, user-informed, prototyping strategy; and a well-vetted plan for smooth transition from legacy systems to new architecture.

12.8.1 Does It Scale?

This question is especially important in the database area. NIMA's online database will have a vector and raster component. The vector component is likely to have a high transaction rate but the total size can be easily measured in terabytes. The imagery component is much larger and while its ultimate size is both speculative and highly classified, a planning figure of several petabytes will do. Except for chunks associated with specific features, however, it is likely to have a relatively low hit rate (perhaps no more than 100,000 requests per day). Will COTS solutions to smaller data problems fail to scale? Or, will explicit systems integration be necessary—leaving no good choice but for NIMA to hand its architecture over to a traditional (read "aerospace") systems integration house?

Although NIMA's database is large, in many respects NIMA's problem is simpler than those of other database managers. Smaller databases such as those of banks, credit card bureaus, and server farms have higher transaction rates, more complex transactions, and more input points. A raster-image database may be huge in overall size, but manageable in terms of the number of items; and the transaction rate is low, most client transactions are straightforward (*e.g.*, file calls), and the number of initial data feeds is limited by the number of (expensive) collection systems. No greater than the number of imaging satellites (with airborne collectors the number may approach a hundred). A vector database may have higher transactions rates and more input points but the total data set size is comparatively smaller.

It will be essential to model painstakingly the expected demands on NIMA's database to determine exactly what scalability problems will exist—storage, file complexity, number of nodes, service requests, or the support of specific applications.

12.8.2 Is the Design Too Tightly Integrated? Too Complex?

Because it forces developers to produce an integrated system periodically rather than at the end, spiral development encourages light and loose versus heavy and tight systems integration. While the latter may promise to be more efficient ultimately, the former is easier to acquire and maintain; in any event, Moore's law usually rescues the less efficient design.

Reducing unnecessary systems integration also makes the overall effort accessible to more contractors, permits the total task to be managed in terms of smaller and faster deliverables, and ultimately, permits unexpected capabilities and requirements to be accommodated more easily.

The integrating mechanisms of NIMA's information architecture are a common communications stratum (*e.g.*, TCP/IP), a common data model, and a common geodesic model (*i.e.*, WGS 84). Systems integration is to be understood as a light appliqué, not the main event, and certainly not the primary criterion for selecting architects and contractors. And whatever systems integration experience is sought should be demonstrated against at least some significant GIS problems.

Still, one cannot ignore completely the systems integration process that ensures that everything that works apart also works together.

12.8.3 Choosing the Right Architects

Should NIMA mount an in-house systems engineering and architectural effort? Can it attract enough talented outsiders through the Intergovernmental Placement Act (IPA) or other programs? Even if NIMA plans to outsource its architecture, the Commission believes that absent some intimate organic capability, NIMA cannot be a sufficiently wise buyer. Absent such expertise, it cannot readily evaluate its own requirements, the architecture that meets its requirements, and the systems that instantiate the architecture. Ineluctably, NIMA must put in place a set of (formal) procedures to validate the architecture.

An architectural goal is to end up with one "TPED" that includes imagery and geospatial data and processes. An architecture that is *data*-centric seems more satisfying to the Commission than one designed around (legacy) products and/or processes.

12.8.4 Planning a Smooth Transition—Prototyping and Evolution

Embracing data-centric and Web-centric designs and moving to a new data model could be somewhat perilous. Test beds can play a useful role in validating and instantiating new architectures. Two approaches are possible. One is to run NIMA's architecture and data model off an extant test-bed architecture such as the one being operated by the Open GIS Consortium (OGC). The other is to sponsor a full-up Advanced Concept Technology Demonstration (ACTD). NIMA may want to do both: use OGC (or a like entity) to perform a rapid check on its geospatial model, and use the ACTD to explore the ramifications of a multi-INT database.

Not all of the database's ultimate features need be in place immediately. Some have to be part of the prototype but others can be installed later. Continuous improvement means tomorrow's capabilities are better than today's in some respects, and never worse. Mistakes should be caught while small and young. Feature expansion will await positive feedback. Most important of all, today's satisfied users will not become tomorrow's dissatisfied ones.

During the transition, users should be able to see familiar products—whether originally hardcopy or soft-copy—and it should be easy for someone to "find the button to push" that can recall the same map from the database as before. The period in which old and new coexist is a trying time, but wholesale conversion of NIMA's legacy database at the outset is probably unwarranted; initially, at least, applications should translate legacy data into usable terms (while writing new data according to the data model).

Some data will prove to be worth less than conversion costs because of age, error, or inaccuracies; other data will be found redundant. The rest have to be moved both across media and from the legacy data structures to the newly developed ones. Great care will be needed for those applications (algorithms) that can only work with legacy data structures—here conversion will be less automatic and more expensive.

In many (more) cases, old algorithms, having lost their customers, will simply be dropped. But the rest have to be painstakingly converted.

What should govern when information is to be converted: when it is needed or when it is received? Working on demand leads to crash programs and delays the availability of information (it is usually too late to inspect details up close once a crisis erupts). Working on receipt risks spending money where it is not needed.[38] No easy answers.

Long-term goals can be approached through short steps. Fielding capabilities as they mature rather than at the project's end permits mistakes to be surfaced early and research has shown that early detection of mistakes reduces life-cycle costs. The development of unexpectedly popular features can be accelerated. If something does not work out, one knows early and can adjust requirements (and expectations) accordingly. However, emphasizing periodic improvements places a premium on backward compatibility and changes the training and configuration management regimes. No free lunch, here.

12.9 The Current State of TPED

The Commission does not have high confidence in NIMA's current ability to accomplish its TPED system acquisition successfully. The current TPED acquisition effort lacks a clear baseline, which should tie clearly to overall strategy, requirements, and cost constraints. In addition to the lack of a common definition of TPED, there is similarly confusion as to the requirements that TPED must satisfy.[39] The Commission learned that in a comprehensive requirements review that helped define FIA, considerable imaging requirements were allocated to commercial and airborne imagery:

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[38] Of course, if we knew when and where the next crisis would develop, we could forgo the intelligence establishment.

[39] The Commission has labored mightily to get this right. It's not easy. We think we are close, but each time the question is posed, the sands shift. It is legitimately difficult to gauge requirements: some requirements are point targets, others are for area coverage; not all point targets are equal, not all areas are equally interesting; peacetime is different from wartime. Complicate this by the fact that some require higher resolution, some require stereo, *etc.* Without making this a life's work, one may still conclude that there will be a disconnect if airborne and commercial do not deliver as originally anticipated.

In peacetime less than 50 percent of required area coverage is allocated to FIA, while commercial and airborne assets accounted for the majority of peacetime area allocations. For peacetime point coverage the reverse is true, with the bulk of peacetime point targets allocated to FIA, and a minority to airborne and commercial assets.

During a major theater conflict, about half of both area and point coverage are allocated to FIA, while commercial and airborne assets combine to meet the other half of all requirements.

FIA holds to the claim that it will meet all its allocations; however, because of negligible budgeting to date for commercial imagery, and proposed reductions in airborne investment, OPSTEMPO and PERSTEMPO—the FIA era still might not live up to its billing as eliminating collection scarcity. Further, the allocation of requirements to airborne sensors implies a concept of operations (CONOPS) that has not yet been articulated. Compounding the problem further still, the Commission could find no credible plans to integrate commercial and airborne products into FIA and/or TPED. Without agreement within the community of what is included in TPED and what requirements are to be met it is difficult to envision a successful acquisition effort.

The Commission received a number of briefings meant to describe TPED and its status. What becomes clear is that NIMA has not articulated a single definition of TPED. One is easily confused about where TPED ends and USIGS begins, or are they one and the same? Does TPED, as specified, support only the collectors that the NRO is acquiring under FIA, or does it also embrace airborne and commercial collectors? Does TPED extend to multi-INT capabilities? These, and other, ambiguities suggest those responsible for its implementation do not adequately understand TPED.

It appears that an acronym for the functions of tasking, processing, exploitation, and dissemination has somehow become the name for an entity without benefit of a common understanding of the content. TPED needs stability in definition and scope (and funding) so there is a common ground for describing and successfully implementing the capabilities needed to support the users. The Commission was treated to a multi-phase view of TPED by ASD(C3I) which clearly shows, in successive phases, the integration of commercial and

airborne imagery assets, and multi-INT integration. If fleshed out, funded, and adhered to, the plan seems satisfactory to the Commission.

In addition, NIMA's current acquisition strategy requires NIMA to be its own system integrator. However, the Commission is not confident that NIMA currently has the system engineering experience, acquisition experience, appropriate business practices, and performance measures to so acquire TPED systems. The Commission sees high risk in NIMA's taking on responsibilities and risks above and beyond that of a simple acquisition agent. But, as argued earlier, NIMA must have sufficient organic capability to be a wise buyer.

As discussed in a preceding section, the Commission observes that TPED is not adequately utilizing commercial hardware and software. Again the Commission is somewhat conflicted as to whether or not NIMA should restrict itself to an acquisition role, ceding most development and systems integration activities.

The Commission observes that current TPED plans only tangentially increase the convergence of imagery and geospatial processes, and also notes that current TPED plans do not effectively integrate airborne and commercial imagery with national technical means. Nor do current TPED plans speak to the issue of multi-INT integration.

As an aside, the Commission notes that the FIA baseline does not support production of film, on which TPED must still rely unless NIMA receives additional resources to move the entire community to soft-copy.

12.10 The Need for an Extraordinary Program Office

The imagery TPED program increasingly strains at the fabric of the NIMA organization as a whole. Repairing the problems cited above, while necessarily adhering to the schedule imposed by the successive generations of imagery satellites—EIS and then FIA—makes the current program far more risky than previously supposed. While we cannot afford to fail, it is not clear that we are prepared to afford success. The stakes are high, the job is

monumental, the time is short, the resources are marginal, and the skilled personnel are slim pickings.

NIMA does not have the organic capability or the experienced technical leadership to successfully acquire TPED, nor can it "get there from here," in time, using normal government practice. There is no help on the horizon because neither the NRO nor NSA has the talent to spare. If the US is to have a good chance of achieving a TPED capability to give the nation the information edge in the 21st century, special steps must be taken to ensure success.

The Commission recommends creation of an Extraordinary Program Office (EPO) armed with special authorities of the Director of Central Intelligence and the Secretary of Defense, augmented by Congress, and staffed beyond ceiling and above "cap" through an heroic partnership between industry, NIMA, and the NRO. The EPO, to be constituted within NIMA from the best national talent, shall be charged with and resourced for all preacquisition, systems engineering, and acquisition of imagery TPED—from end to end, from "national" to "tactical". The first milestone shall be completion of a comprehensive, understandable, modern-day "architecture" for imagery TPED. Other provisions of law notwithstanding, the Congress shall empower the Director of the EPO to commingle any and all funds duly authorized and appropriated for the purpose of the "TPED enterprise," as defined jointly by the Secretary of Defense and the Director of Central Intelligence.

12.10.1 To Establish the Baseline Architecture

An accelerated schedule helps avoid mission creep. The Commission estimates that the first four months should see (1) a preliminary data model constructed, (2) estimates of the time and resources required to convert legacy data into standard digital form (see below), and (3) a succinct requirements statement based on the principles above. Architect selection should proceed expeditiously with the actual work completed in three phases of six months each. The first phase should be specific enough so that the work of converting legacy data can begin. The second phase should be good enough to budget the next five years of TPED acquisition. The last phase should be the basis upon which software can be written and acquisitions begun.

12.10.2 To Migrate Toward a Data-Centric, Web-Centric Design

TPED should not be based upon NIMA's current processes and products. Instead, as elaborated upon in the succeeding section, processes should be considered as Web-enabled transactions against a database; products can be pulled from the database or created by "servelets," "applets," and/or client software. The design should inherently foster imagery-GIS convergence.

12.10.3 To Integrate Airborne and Commercial Imagery with NTM

The Commission has not seen evidence that an integrated plan exists that utilizes airborne, national, and commercial imagery in a cooperative effort to meet all imagery collection requirements. In addition to the comments above concerning requirements allocation among the various collectors, the Commission was not exposed to an integrated CONOPS utilizing imagery from all three sources—national, airborne, and commercial. Such a CONOPS requires close coordination with CINCs who currently have control over theater assets. An operational plan would also require agreement with commercial providers on issues such as amount of imagery to be provided, quality control, responsiveness to USG needs, and methods of exploitation.

Further concerns about the lack of integration among airborne, national, and commercial imagery are made evident by the fact that the TPED functions; namely, tasking, processing, exploitation, and dissemination for each of these imagery providers are essentially different. The fact that NIMA has not discussed these functions individually nor indicated how these functions would be accomplished for each imagery source in a cooperative environment is an indicator of the lack of an integrated plan.

12.10.4 To Integrate Libraries and Communications

Dissemination (including the communications for distribution) is arguably one of the more expensive portions of the imagery intelligence cycle. One of the critical elements of this service is the communication links. These links connect tasking authorities to collectors, collector data to processors, processors to exploiters, information to users, and users to tasking. These links must be secure, robust, high capacity, and both long and short haul.

It appears to the Commission that the lines of responsibility between TPED and communications systems, both terrestrial and space, have been blurred. The danger in this approach is that no one becomes responsible for the enterprise operating as a unit. The dialogue so far between NIMA, DISA, NRO, and the user community engenders no confidence that the links will be there when needed. It was not made clear to the Commission as to who has responsibility for the "last tactical mile." It does not appear that NIMA signed up for that responsibility—and it certainly is not resourced for that, nor should it be from "national" funds, by some accounts. However, the CINCs and Services conveniently profess not to know where TPED ends. This is not good.

Clearly more dialogue is needed to define the boundaries of TPED, responsibilities, and interfaces. Part of the difficulty in having this dialogue is that communications is considered both multi-user and multi-use; it is expensive given the bandwidth needed for imagery and geospatial product delivery—in fact, once imagery-quality bandwidth is provided, almost everyone else "rides for free." The Commission is uncertain whether an Intelligence Community communications architecture exists.[40] The Commission is pretty certain that if it does, it does not stretch to the foxhole, wheelhouse, or cockpit. While such architecture is not necessarily a NIMA responsibility, it is necessary for TPED to be successful. Given this situation, it is difficult for the Commission to have confidence that the capacity for FIA and/or USIGS will be available when needed.

12.10.5 To Support Multi-INT TPED

Despite the fact that material describing USIGS implies use of, and integration with, other Intelligence sources such as SIGINT and MASINT, the Commission found little evidence

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[40] By some accounts, the Defense Information Services Agency (DISA) is responsible (for DOD) end-to-end architecture; indeed, DISA's Global Information Grid (GIG) presumes to extend across the last tactical mile, although the Services have not yet been heard from on the notion. Even if DISA harmonizes with the Services, the situation is clouded by the fact that intelligence networks have traditionally been separate from DISA networks. They can run at a higher classification and, given the out-bound imagery bandwidth requirements and the in-bound SIGINT requirements, intelligence traffic would dominate by far a common use network. For these and other reasons, the Intelligence Community has been noticeably reticent in placing its future in DISA's hands.

that integration is inherent in the TPED program.[41] Solutions to portions of the imagery problem set generally require the integration and fusion from all sources with very short timelines and the Commission agrees that all-source TPED is needed. Multi-INT requires as a minimum the following elements: tasking processes based on required information rather than INT-specific observables; interoperability between TPED systems, MASINT, and SIGINT information embedded in the USIGS library; and multi-INT workstations equipped with exploitation aids.

A review of the current operational and planned space and airborne capabilities indicate efforts to support TPED functions within each discipline with little planning for integrated systems or functions across the current stovepipes. The NIMA TPED program does not fully address this problem. Moreover, there is some question if NIMA has the authority, expertise, and budget to execute the necessary programs. As a minimum, NIMA should have complete understanding of the relevant programs that its mission partners and others are pursuing and efforts made to coordinate these efforts. The Commission was not exposed to relevant TPED efforts at NSA and CMO regarding SIGINT and MASINT nor did it hear of cooperative efforts among NIMA, NRO, NSA, Central MASINT Office (CMO), or others for multi-INT TPED other than plans to develop a shared requirements database.

12.10.6 To Address TPED Implications of JCS-Identified FIA Shortcomings

There are five significant FIA shortfalls defined by JCS that have major TPED implications and have not been considered in the current architecture. Without going into the specifics, which are classified, the Commission wants to plant the marker that augmenting FIA with any or all of the shortfall-capabilities must also provide for the TPED implications of the FIA improvements. In the spirit of Total Cost of Ownership (TCO), the Commission expects the bills for the upgrades to be calculated taking TPED modifications into account, and budgeted for as a piece.

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[41] However, the multi-phase view of TPED espoused by ASD/C3I clearly shows multi-INT integration as a later phase. As the C3I vision becomes better defined and funded it will alleviate Commission concern.

12.11 Creating the EPO

The special authorities of the DCI should be used to create the "spaces" and the DCI and SECDEF should intercede personally with the private sector to get the "faces" to fill those spaces. Congress should codify the exceptional measures needed to set up and operate this Extraordinary Program Office (EPO). The Commission believes that the EPO should be created within NIMA.

It is anticipated that the EPO shall have a five-year lease on life, after which the Director of the EPO and D/NIMA will have arranged for a smooth transition of the required capabilities into NIMA proper.

Elements of an EPO;

- ✓ Confer the special authorities and organization to make the EPO architectural development viable.
- ✓ Recruit a national team of expertise for at least a three to five year period.
- ✓ Institute a world-class system engineering and information technology capability.
- ✓ Install an effective procurement and contracts capability commensurate with EPO.
- ✓ Assure that the aerospace industry does not dominate the business of EPO.
- ✓ Adopt the most effective government/commercial programmatic tools on a priority basis.
- ✓ Simultaneously build an in-house SE/IT capability in NIMA for the longer haul.
- ✓ Oversee TPED and R&D as related but separate programs, *i.e.* strong R&D that is not raided by TPED development.
- ✓ Use a sound business plan as the basis for EPO activities.
- ✓ Assure the architecture is in line with the Strategic/Organization/Management considerations.
- ✓ Give priority to sorting out consistent approaches to IEC and OET/WPF.

- ✓ Ensure that EPO architecture is not proprietary but is based on open systems.
- ✓ Assess the scope of integration of new technologies associated with new collection techniques.

12.12 Technical Advisory Board

The Commission feels that the Director of NIMA would benefit from outside technical expertise, in the form of a Technical Advisory Board with whom he might meet periodically to review key TPED acquisition (USIGS modernization) milestones and top-level design presentations. The Board would also represent a resource on which the Director and his senior acquisition and technology officers could call as required.

13. NIMA Research and Development: A Road Less Traveled

NIMA inherits from its forebears, principally NPIC and DMA, a spotty record in research and development, which was largely done by others on behalf of these organizations. Inasmuch as the Commission recommends that NIMA be an "acquiring" organization, versus a "developing" organization, it is hard to argue for an in-house R&D capability of other than the most modest proportions. Nonetheless, there is considerable merit in looking over the shoulders of those who do research and there is considerable research and development that could profitably be undertaken to support NIMA's mission. It is important, then, that NIMA be an smart sponsor for such R&D—smart in the sense that it knows, generally, what technological breakthroughs will advance its mission, and that it has some plan for technology insertion if and when R&D delivers.

The Commission is quite concerned about the level of research and development conducted by and on behalf of NIMA. Imagery and geospatial activities in the national security sector are only partially congruent with those of interest to the commercial information technology sector. The Commission is convinced that inadequate R&D holds hostage the future success of TPED, USIGS, and indeed of US information superiority. Here, we provide some examples of areas where NIMA, and its R&D partners, need to be cognizant, if not involved directly with advanced technology.

Specializing in the higher value-added aspects of TPED will ultimately require NIMA to do more technology. Maps and electro-optical images are readily understood, the former through tons of experience and the latter through analogy with the human eye. Even multispectral imaging (MSI) is just a color image. But by the time one gets to the fine spectral slices of hyperspectral imaging (HSI), much less ultraspectral imaging (USI), analogy to human experience thins. One needs, for instance, a thorough catalog of objects and surface chemistries to detect the meaning of this or that reflection. This also holds true for sophisticated synthetic aperture radar (SAR) interpretation. Even more technology is necessary to defeat the natural effects of atmospheric distortion or the deliberate effects of

denial and deception. Further research is also warranted for ground and air moving target indicators (AMTI and GMTI) technology, which, when combined with SAR technology, might possibly provide innovative ways to find targets such as SCUD TELs, for example.

Speed (faster cycle-times) is another potential area of competitive advantage that can be enhanced by technology. An enormous ground infrastructure helps NIMA bring large volumes of space-based imagery to earth quickly. But further networking and error-correction technologies are required in order to fulfill the promise of sensor-to-shooter, or more so, sensor-to-seeker–especially if NIMA is required to provide informed, real-time input without slowing the decision loop. Similarly, distributed access–the ability to get product into a variety of devices by taking proper account of their limitations (e.g., a palmtop's limited screen and memory)–is another potentially rich technology thrust area. Techniques to recognize targets or detect changes automatically can permit analysts to examine much larger swaths of territory and defeat an enemy's strategy of hiding in the vast open. Similar techniques and technologies can also counter an adversary's strategy to hide what he is doing through denial and deception.

In the very near future, third generation wireless handheld devices will be available with much higher data rates, digital and voice data, integrated with or connected to GPS, Intel and other CPUs, laser range finders, azimuth indicators, map and image display devices, etcetera, making the sensor-to-shooter-with reachback technologically achievable. The Joint Expeditionary Digital Information program has demonstrated many of these interconnected capabilities with second-generation wireless devices. Experiments with this program at Fort Polk during the Army Warfighter Experiment were, on balance, very successful in demonstrating the promise of this sort of capability.

The DoD vision of joint fire against time critical targets requires imagery and geospatial communication "with the foxhole" (weapons system, platform) in order to provide the georeferenced updates that are essential to the Common Operational Picture (COP). NIMA, with its obvious vested interests, should have a technological leadership role in this area.

Geospatial precision is another current and potential strength of NIMA. The ability to render operational areas in three dimensions supports a simulation ability good enough to be considered virtual reality–and indispensable for preparing warfighters for difficult missions. Accurate digital elevation modeling permits closer nap-of-the-earth flying, an increased ability to use terrain to mask or unmask operations, and better weaponeering. Accurate geolocation and mensuration can enable new generations of fire-and-forget weapons with less risk of collateral damage. New instruments, greater sophistication in their use, and the innovative use of knowledge bases can yield substantial gains in accuracy.

NIMA should aggressively explore ways to realize the large potential for improving effectiveness through the "force multiplier" opportunity in automated extraction tools for both geospatial and image analysis.

In general, NIMA ought to be led more aggressively in the search for collaborative relationships with all organizations doing imagery and geospatial R&D including the CIA, NRO, CMO (Central MASINT Office of DIA) and even civilian agencies (e.g., DoE's weapons detection software, and NIH's image-extraction from mammography research) as well as public and private corporate high-technology institutions (e.g., Charles Stark Draper Laboratory, MIT, Stanford and commercial contributors).

But tracking and performing R&D across such a spectrum requires funding. The Commission finds that NIMA's current budget for R&D is far from adequate, and the Director of NIMA is committed to trying to increase the NIMA R&D account. The Commission agrees that a larger percentage of the NIMA budget should be devoted to R&D, once the overall budget realistically is consonant with the mission. To set a benchmark, the Commission notes that the NRO's Directorate of Advanced Science and Technology (AS&T) has a firm claim on 10-percent of the NRO's resources. The Commission strongly believes that D/NIMA should direct that creation of a technology road map to encompass the domains discussed above. It may not matter whether the R&D is executed within NIMA or is contracted out to centers of excellence in various organizations under NIMA's direction.

While the Commission did not dwell overly long on a search for technologies that could materially improve NIMA's prosecution of its mission, it does offer the following table of technologies that, on the surface, at least, could be profitably pursued. In fact, there are few if any surprises in that table, and many of the topics are addressed at some level at various times.

Technologies That Can Provide the Edge

Multispectral Imagery (MSI) Hyperspectral Imagery (HSI) Ultraspectral Imagery (USI)	MSI, HSI, and USI are technologies to collect precise imagery of successively finer spectral resolution. The NIMA advantage would be the ability to extract useful information from images otherwise unremarkable to the human eye.
Synthetic Aperture Radar (SAR) Ground/Air Moving Target Indicator (MTI)	SAR and MTI permit all-weather day-night imaging of objects and detection of those which are moving. The NIMA advantage would be processing such information to find and characterize mobile targets in real time.
Ground Infrastructure Space Relays	They permit large and fast dumps of data from space and the ability to circulate such information in quantity once landed. The NIMA advantage would be greater collection (because storage between drops is less a constraint) and faster image processing (thanks to fast picture-cleaning and because satellites are in more frequent contact with the earth).
Sensor-to-Shooter Sensor-to-Seeker	Real-time linkages from sensor assets directly to warfighters or weapons, respectively. The NIMA advantage would be the ability to strike targets while at or near where they are found (or can be predictably tracked to).
Distributed Access	The ultimate expression of NIMA-in-a-box; imagery intelligence and other GIS information to the foxhole (or cockpit, or CIC). The NIMA advantage would be the ability to give warfighters exquisite situational awareness and precise targeting.
Automatic Target Recognition (ATR) Automatic Change Detection	They permit large images to be scanned by computer with relevant details (*e.g.*, targets, changes) picked out. The NIMA advantage would be the ability to process large areas quickly (*e.g.*, to find SCUDs or detect potential nuclear detonation sites).

3D Virtual Reality	The ultimate mission-planning tool. NIMA's advantage would be the ability to insert accurate three-dimensional GIS data (*e.g.*, urban data, imagery atop topographic data) to permit mission testing, and rehearsal on the fly.
Counter Denial and Deception (D&D)	D&D permits adversaries to hide or fake what they are doing from sensors. The NIMA advantage would be the ability to defeat such strategies.
Digital Elevation Modeling	Deep detailed knowledge of the earth's surface. The NIMA advantage would be in supporting terrain-following weapons (*e.g.*, cruise missile TERCOM) and terrain-masking tactics (*e.g.*, used by Apache Longbow), and one day, more effective urban operations.
Geo-location and Mensuration	The ability to locate and measure objects precisely. The NIMA advantage would be the ability to do so without ground reference points.
Automated Map "Finishing"	Anything that would permit automatic finishing would not only save man-hours, but permit NIMA products to appear at intermediate resolutions (*e.g.*, 1:100,000 rather than just 1:50,000 or 1:250,000). The ability to update data sets from imagery without human intervention would be helpful when supporting operations with timelines measured in hours and days.

14. NIMA and Its Information Architecture—A Clean Sheet

As mentioned previously, the Commission is enthusiastic about the Director's reformulation of NIMA as custodian of the US Information and Geospatial Service (USIGS). Sometimes misunderstood, this reformulation is emblematic of a healthy change in focus, away from systems, away from products, away from processes, and toward information services. This is not to say that NIMA will no longer produce its hallmark products: maps and imagery intelligence products. As NIMA focuses on information services, the hardcopy maps and reports are byproducts—intentionally useful derivatives, but not the essence of NIMA.

A critical consequence of the reformulation is the need to get the information architecture just right. Otherwise, the future extensibility of USIGS will be severely limited. New applications will not be able to flower.

A sub-panel of the Commission took a look at a possible architecture unconstrained by any legacy issues—a "clean sheet" was the starting point for a top-level design exercise. The conclusion of the sub-panel, endorsed by the Commission as a whole, is that to support NIMA's transition to an information service, the USIGS information architecture must become "data-centric." To anticipate the discussion, this means that all TPED processes—and subsequent analytic processes, as well—become transactions against the database, each deriving value from, and adding value to, the database.

14.1 The Importance of Architecture

The importance of focusing considerable energy on NIMA's information architecture cannot be overstated. NIMA is embarked on a major acquisition initiative for its tasking, processing, exploitation, and dissemination (TPED) process, which will, for better or worse, solidify its information architecture for a decade or two to come. The Commission fears that, left to its own devices, NIMA's information architecture could well remain system/function-centric, structured around discrete systems purchases made several hundred million dollars at a time. While these systems could be individually coherent, and would likely meet current stated

requirements, they would neither position NIMA to take full and continuing advantage of the revolution in information technology, nor interface gracefully to systems and processes as yet unimagined.

To oversimplify slightly, the Commission is inclined to believe that TPED and other major applications would be best served if NIMA were to develop a new architecture, a new process by which to acquire this architecture, and a new organizational form to take advantage of it. The new architecture would be built upon a distributed database that integrates geospatial and imagery information—and can extend to encompass information derived from other "INTs". The new process would adopt COTS to the maximum useful extent, built in terms of periodic increments, and cut back on requirements for systems integration. The new organization would focus NIMA on its emerging role as content provider for the Global Information Grid (GIG).

It is with temerity that the Commission offers for consideration this more detailed discussion, not to provide a blueprint, but to illustrate how fundamental changes in architecture create fresh possibilities—yes, and raise new issues. It should neither be accepted uncritically, nor discarded petulantly. It should serve merely to illustrate how rethinking TPED without preconceptions can inform the structure and composition of NIMA's information systems, and indeed, NIMA itself. The Commission realizes that insofar as there are sound ideas here, they are neither unique to the Commission, nor absent in NIMA's own thinking.

14.2 Toward a New Architecture

Only half jokingly has NIMA, in its current configuration, been described as "two communities separated by a common agency." Imagery analysis, with its intelligence heritage, is quite comfortable with its functionality allocated as TPED. Geospatial analysis, with its cartographic heritage, is less well served by the TPED nomenclature and more at home with order entry tracking (OET) and work flow management (WFM). While either argot could be adapted to (or adopted by) either community, the data-centric construct accommodates both. The Commission cautiously asserts that beyond being an inclusive construct, data-centricity is a unifying construct.

NIMA is perched on the edge of a systems acquisition that will influence its information environment for years to come. This provides NIMA with a unique opportunity to consolidate

its information architecture. The Commission believes that NIMA's information infrastructure should be *built around an integrated data architecture, not around a collage of systems, nor products nor processes.*[42] Actually, the Commission's view is grander still. If done skillfully, NIMA would become the architect, if not the custodian of the Geospatial Information System for the larger national security community—intelligence and operations, diplomatic and military, strategic and tactical.

This "mother of all databases"[43] at the center should be the conceptualization, if not the container of all the national security community's geo-referenced (and time-tagged) information.[44] Indeed, nearly all relevant information is, or could profitably be geo-referenced. "The Central Database"—which need be neither singular nor centralized—must be widely and easily shared among users and, in the first instance, should hold vector data (the stuff of maps) and raster data (the stuff of images) as a seamlessly packaged whole. The database should be structured to be independent of client or application, fully distributed, and capable of accepting successive value-additions and user annotations. These features would depart from NIMA's current information architecture (though some of NIMA's as-yet-unimplemented plans pull in that direction).

14.3 A Database to Support the TPED Process

As shown in the accompanying illustration, such a database could constitute the primary—not necessarily sole—support for the imagery TPED process; indeed, it would support any number of TPED processes as such.

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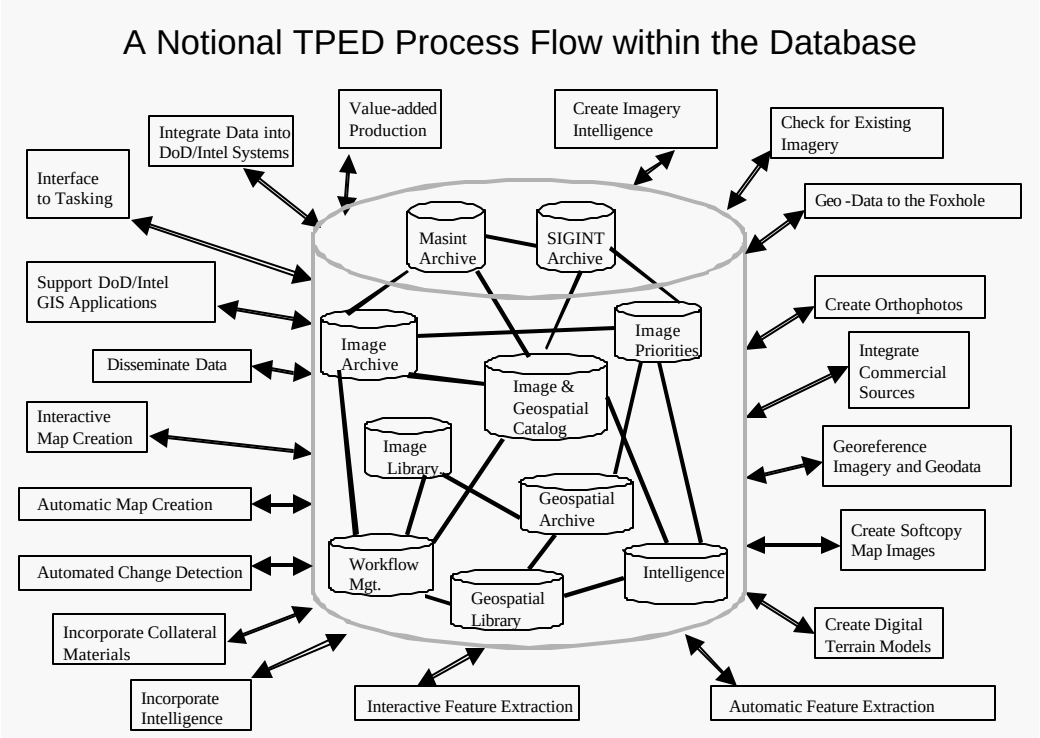
[42] Advocating that NIMA develop a data-centric architecture rather than a system-centric, product-centric or process-centric architecture may seem, at first, to run counter to today's government and business practices. Normally, one first determines the business processes critical to the organization and then designs an information system to meet these. For NIMA, though, *information is the product*.

[43] With apologies to Bran Ferren.

[44] It will be worth exploring whether, and to what extent, the MIDS-IDB database administered by DIA should form the conceptual core of a new data-centric architecture.



All TPED functionality—from requirements and tasking, to data reception, processing, exploitation, and dissemination—can be seen as transactions against a database. That this database may be parsed, distributed, replicated, aggregated, and so on is key. Transactions—the value added to data in the database—need not adhere to the sequential implications of traditional TPED interpretation.

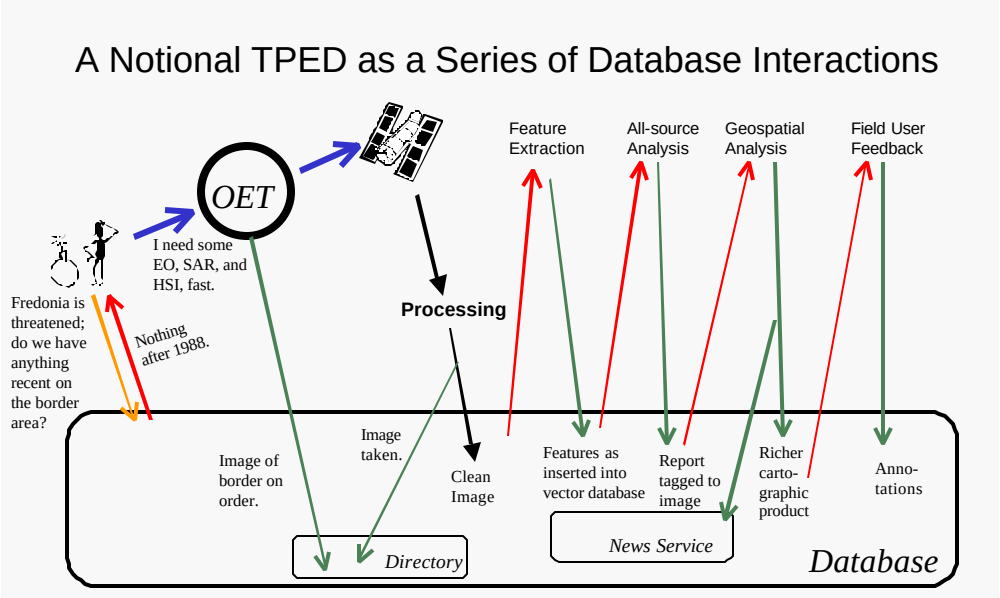
14.4 Tasking, Processing, Exploitation, and Dissemination as Transactions

Tasking flows from an expression of information needs and logically starts with an investigation of what already exists—Are the data in a database? Is the product already in inventory? If so, pull it. If not, order it. Ask that it be pushed to you, or ask to be advised as to when it is available to be pulled. In the "back office" the order is processed—pulled from a queue, or pushed to the fulfillment process. Different views—depending upon whether one is in front of the counter or behind the counter—which can be reconciled as transactions against a database. Much can be relegated to server applications: notification, standing taskings, and the like.

Processing, in the first instance, refers to turning the information downlinked from the satellite (in what we might refer to as a "proprietary" format) into a "picture" ready for

exploitation, on film or on soft-copy. Processing operations are, generally, done for each picture and so it makes sense to do these prior to the exploitation phase, on large capable hardware close to the downlink entry point. If and when exploitation operations become so routinized that they can be done automatically—say, change detection—then that process might well migrate from the exploitation segment and move "upstream" into the processing segment. In organizational terms, this could mean that NIMA cedes control and execution of these processes to the National Reconnaissance Office (NRO) or commercial operator. No matter who, insofar as the original downlinked information is archived, then successive processing operations can, too, be seen as transactions against a database.

In the same sense, the succession of value-added exploitation steps can be seen as transactions against the database. The (copy of the) image is pulled from the database, value is added, and the modifications and/or modified picture are written back into the database. Thus, exploitation can also be seen, as in the accompanying figure, as a series of transactions (involving imagery but also related vector information), which can continually enrich the database with new features (*e.g.*, a newly discovered double-perimeter fence line) and annotations upon old features.



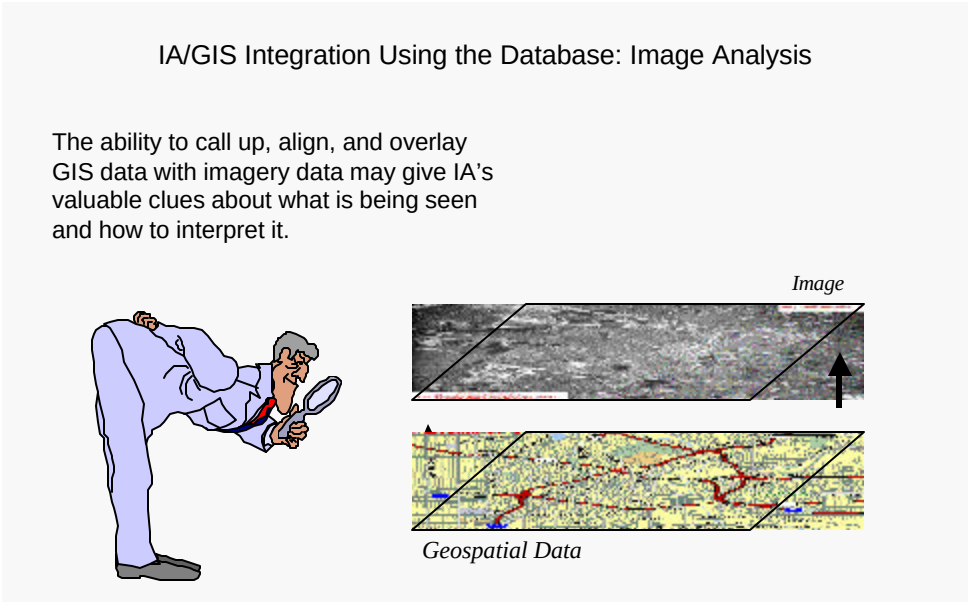
TPED Can be Perceived as a Process of Continual Database Enrichment

Dissemination—the intellectual task of deciding to whom information should go, as distinct from distribution, which is the process of carriage—entails both "push" and "pull." In the former case, a background process—driven, say, by tables that codify users' expressions of needs and wants—runs against new postings to the database and sends that information, or a notice of new information to the desirous users. In the pull case, users run queries against the database holdings. Indeed, if the query language allows the user to specify not only how far back in the archive the search should be conducted, but also how far into the future, the distinction between push and pull logically disappears.

We have taken the liberty, in the preceding discussion, to pretend that there is actually one integral database. That need not be the case, and some would argue that in terms of implementation, no one database could possibly satisfy all. But, the master geo-referenced database still holds its position as the logical source of and sink for NIMA work.

14.5 Vector-Raster Integration

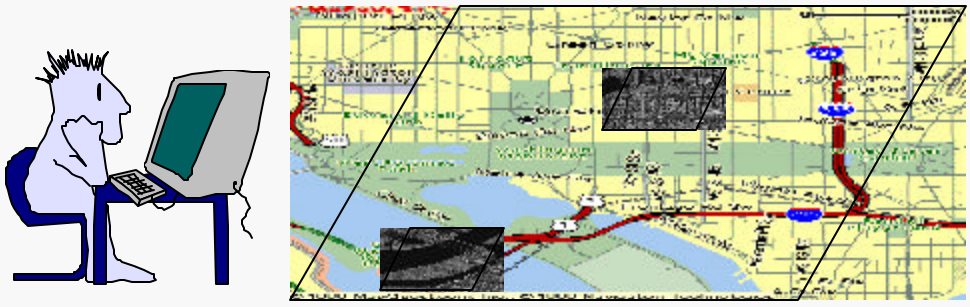
The NIMA database ought to permit clients to access vector and raster information in an integrated fashion—*i.e.*, "normalized" to each other so that the user can drape one over the other seamlessly and transparently. As the accompanying figure suggests, image analysts themselves may be able to do their jobs better by being able to see "through" images into underlying geospatial data (or take advantage of geospatial analysis that may indicate, for instance, likely hiding areas for SCUDs; see *A Tale of Two Cities*, elsewhere in this report).



Today, such a database would naturally contain "chips" of an image—*e.g.*, polygons containing interesting pieces of the larger image. Today, the polygon would be determined by geospatial coordinates—say, a rectangle 2km by 3km centered on a set of geo-coordinates, the "aim point." Eventually, we can expect the chips to be determined more by imagery content—a building, or a compound, or the right-of-way along a road. In either case, a goal is to accommodate better the "bandwidth-challenged" user—fielded forces, those at sea, or airborne. Even with conventional compression, the "last tactical mile" generally constrains us from sending full-size images, which will, themselves, get larger with the next generation of imagery satellites just about as fast as bandwidth will increase. So, the ability to combine vector-map data (which are generally compact for the area covered) with imagery extracts of key visual features, may be the best of all worlds.

IA/GIS Integration Using the Database: Cartography

The value of maps can be enhanced if they can automatically call up and absorb relevant imagery.

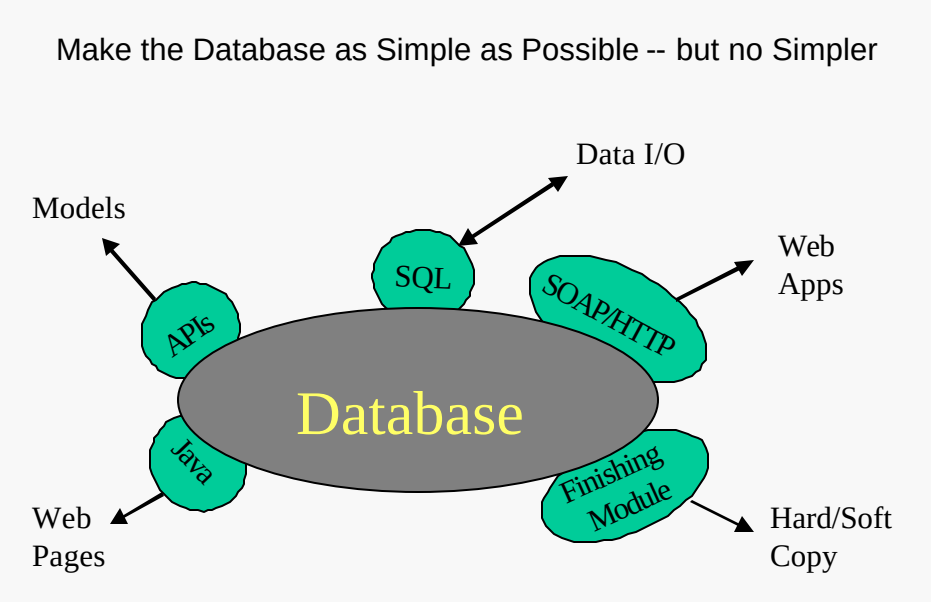


14.6 Product, Application, and Client Independence

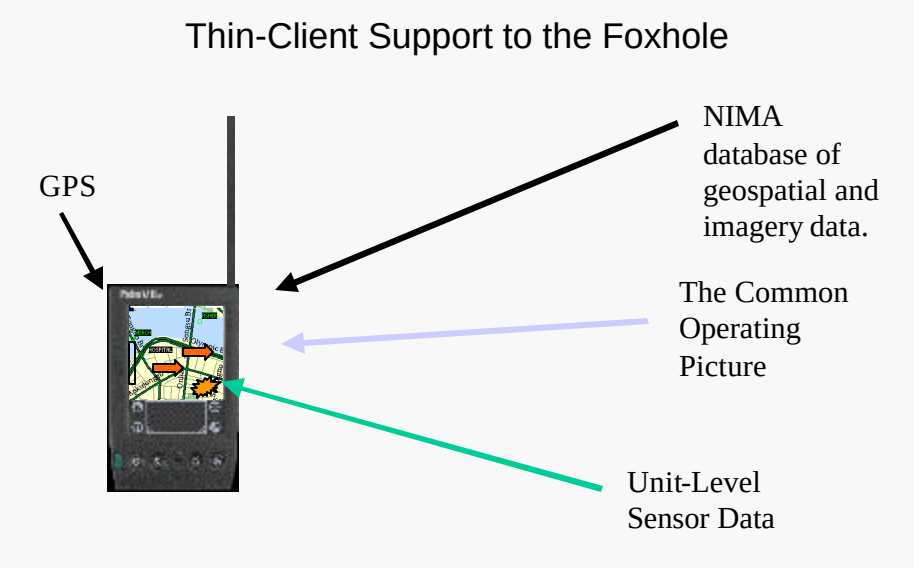
For many users, NIMA still is defined by its catalog of standard map products, paper or CD-ROM.[45] The Commission believes, however, that such products are better thought of as renderings of datasets extracted for specific purposes from a larger database. Users themselves create "products" from the database that NIMA provisions. A "standard" product becomes one where a script has been generated to ensure some uniformity in the data extraction and rendering.

Where once NIMA's job was to make maps, tomorrow its job will be to provision the database and ensure the availability of applications that enable a user (or another application) to call for data using a combination of coordinates, scale, feature sets, and in some cases, currency (what time period is relevant) from an integrated database. Data should be accessible through multiple methods, as shown in the accompanying figure. GIS data can also be used (and thus should be formatted to easily be used) as an input to planning, modeling and simulation, and planners may be able to exploit the database without ever having to see a map or an image.

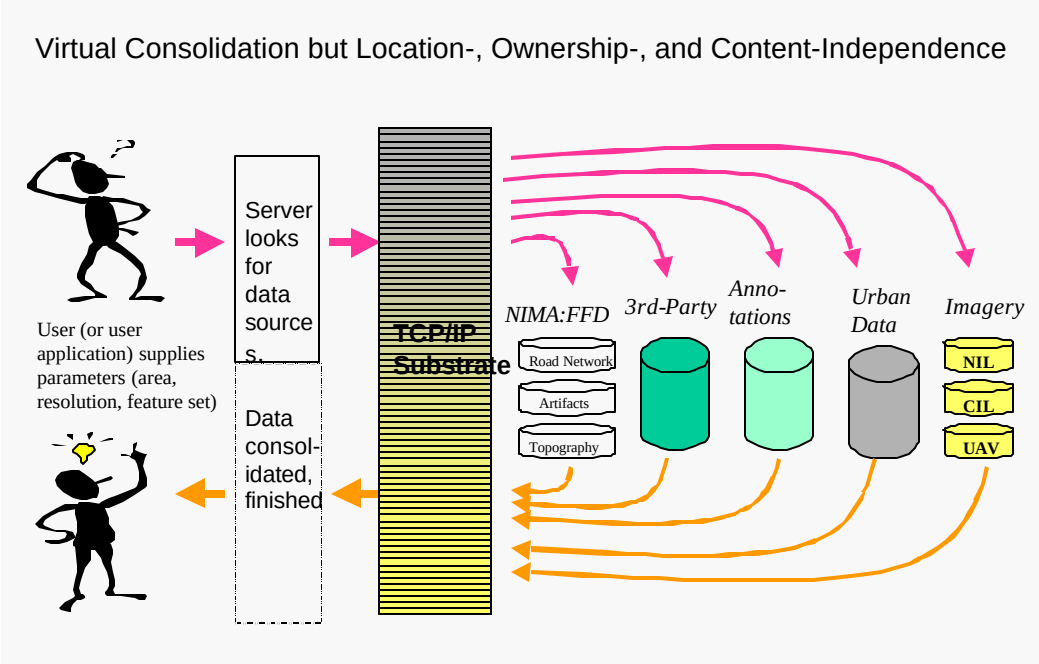
[45] There were 283 products at last Commission count.



The ability to call on NIMA's database through standardized function calls should be a capability that others can build into their products. The separation of client and server functions through modular interfaces also eases the systems integration problems (the importance of which is discussed below). Support must be provided for both thick clients with software powerful enough to manipulate and finish the product and thin clients which can only display a map as a picture but cannot manipulate it as data. Overall, the user interface should be a function, not of the database, but of the user's requirements.



Making GIS data broadly accessible via standard protocols permits anyone to build new applications for users. This frees NIMA from having to guess how its data will be used, and allows unanticipated uses to flourish. The data provider simply cannot be prescient enough to anticipate all the uses to which the data will be put. Traditionally, however, data can be seen only through conforming applications, and manipulated only through routines built into the applications themselves. The software behind the Common Operational Picture (COP: the real-time view of the battlefield), for instance, has no macro language. Best commercial practice, however, avoids this dead end, and so, too, must NIMA.



14.7 Location Independence

The "NIMA database" can (and should) be distributed both physically and virtually. As the accompanying figure illustrates, it suffices that one node "know" where all the relevant data sits; the many data streams that go into a GIS system may sit in various locations (and be managed by various owners within and without NIMA) as long as their interconnections—through the GIG, say—are sufficiently robust. Storage, communications and processing all trade off against each other and best effect can be achieved when a single architect has the freedom to make all the tradeoffs—*i.e.*, to globally optimize the network design.

"Ownership" of data ought to be divorced from locality. There is no need to invest the CINCs with responsibility to hold and manage a set of images taken with national assets over its AOR (area of operational responsibility); it is not even clear that information acquired with theater assets (*e.g.*, UAVs) ought to be part of an exclusive CINC image library as well. True, leaving the command image libraries in place may be optimal from the networking point of view—as long as they are globally accessible. But how users "see" the database can be expected to vary only with their employer, clearance, and need to know.

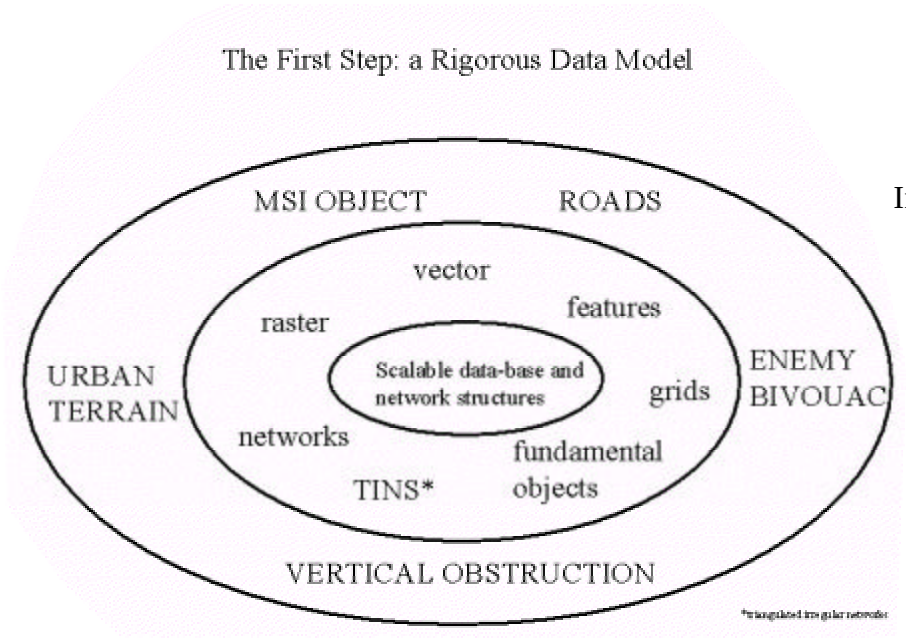
14.8 Annotation

The "NIMA database" must support value-added contributions from anyone, anywhere—the database must host user-supplied annotation. This opens it to a good deal of informed (but, alas, also uninformed) commentary but it also gives users a stake in understanding the GIS database because of their ability to contribute to it. (Although the emergence of client-to-client programs, such as Napster, suggest the distinction between clients and servers is eroding, all NIMA information should be server-accessible because client connections are uncertain and security implications of client-to-client connectivity have yet to be fully explored).

Over time, annotations should become a very significant part of the total database. Indeed, the value of having the database capture the feedback of users (both from DoD and the rest of the Intelligence Community) could rival that of the database itself. Annotation should be understood as exactly that: not the official database, itself, but commentary thereon. Thus, NIMA would retain responsibility for the master plot.

14.9 The Need for a Rigorous Data Model

In developing an architecture for the NIMA database a rigorous data model inherently comes first. All other decisions (such as the systems model) ought to follow, not lead. Such a data model can be conceptualized as the three concentric rings of the accompanying figure. In the center are the core scalable database and network structures (*i.e.*, the processing, storage, and distribution engines).



In the middle ring are the basic data types of a GIS: raster data, vector data, features data, networks, grids, TINs (triangulated irregular networks), fundamental objects etc. In the outer ring are constructed objects (*e.g.*, a street, a multi-spectral image, a vertical obstruction, an "urbanized area"). Such a data model, therefore, would contain a definition of feature classes, metadata, and symbology.

14.10 Ways to Absorb Data from Third Parties

Commercial GIS users are beginning to benefit from the widespread sharing of data sets. NIMA need not create all the information it provides. NIMA already has information-sharing agreements with many governments, and prospects for further sharing appear likely. Datasets can be acquired from other US departments and agencies, as well as from industry.

There are many data sets (*e.g.*, where embassies are located) that other entities (*e.g.*, the State Department) can affordably keep track of much more accurately than can NIMA, itself. There is no good reason for NIMA not to mirror such databases within its own system (mirroring eliminates the very significant problem of combining classified data with unclassified data and second, of thin or unreliable connections to third party servers).

Overall, the more NIMA's data model is compatible with counterpart data models used by the USGS, NOAA, FEMA, major allies, or key NGOs (*e.g.*, the World Bank)—the better. NIMA is best off adapting and adopting commercial standards that work. But where standards do not yet exist, NIMA has to step in to foster their creation to permit greater interoperability and collaboration. The VPF format used in VMAP was developed by NIMA; its success was verified when others (*e.g.*, NATO) adopted it. It helped that NIMA reached out to the

community in developing VPF and like activities in the future should have as much participation of the commercial world as they can get.

14.11 Methods to Deal with Logical Inconsistencies

At one level, logical consistency appears to be the *sine qua non* of a map. Roads are expected to connect, boundary lines to join at their edges, and most buildings sit over land not water.

Unfortunately, although reality may be consistent, databases often are not, especially when they come from different sources, or were made at different times. (both may have been right when made but may have been made at different times). The traditional approach—make it right—may not be the best. The desire to make things consistent inhibits incremental database updating in favor of explicit versioning. Flagging contradictions may be better than arbitrarily declaring one right and one wrong.

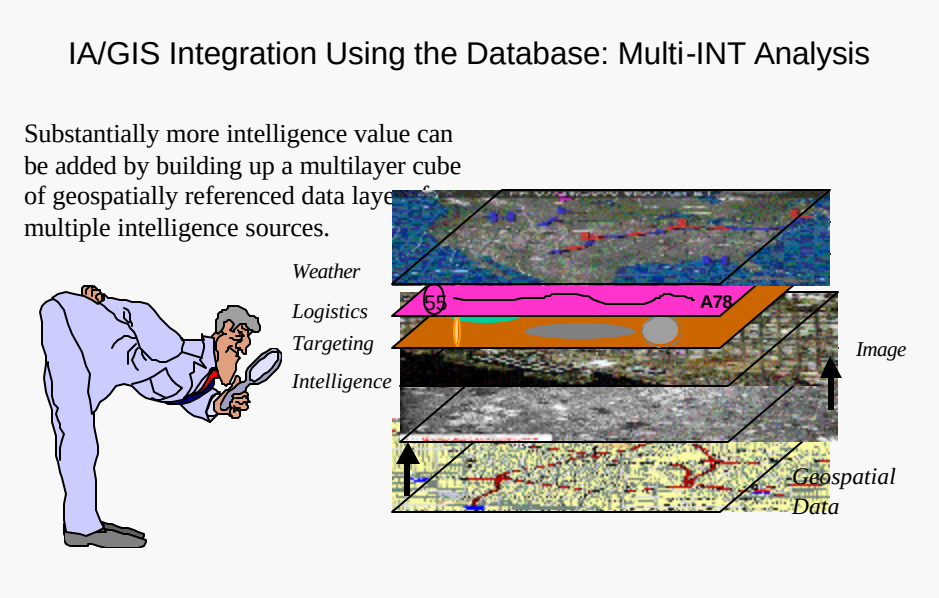
14.12 Methods to Separate Public from Restricted Information

NIMA's total information base can be divided into what is unrestricted and what is restricted—either by license and agreement or because of sources and methods. Currently almost all of NIMA's digital cartographic products are restricted for one or another reason. NIMA should continue to exert care in not confusing the protection of intellectual property with the protection of sources and methods so that legitimate government users need not have a security clearance merely to access "the database" for information that is not classified. The discerning reader will recognize the need for separation, yet integration of information as that old bugaboo of *multi-level security.* The Commission has no answer other than to suggest that *multiple levels of security* is a here and now solution. The paradigm shift that is hard for some to make is to do database operations at the lowest possible level (not "policy high") and then replicate the data to higher levels. To NIMA's credit, they seem to understand this. NIMA will also benefit from the DOD-wide rollout of a Public Key Infrastructure (PKI) and a concerted effort at Information Warfare Defense/Defensive Information Operations (IWD/DIO) designed to preserve the confidentiality, integrity, non-repudiateability and availability of essential information. And fortunately, although security is an area where the federal government often leads the private sector, commercial firms have increasing motivation to solve this problems of protection of intellectual property and privacy of proprietary data.

14.13 New Data Types

"The database" should be capable of holding new data types such as HSI, video, SAR-MTI and urban data. Each presents its own problems and taxes the extensibility of database design and the prescience of the data model. No simple answers are at hand except an open mind.

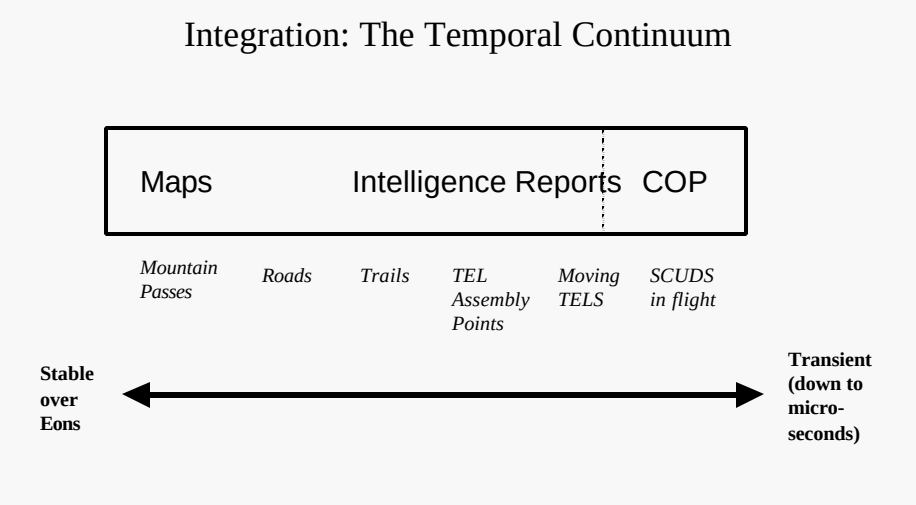
Powerful examples of the benefits of fusing multiple sources of intelligence are widely known, even if less-widely emulated. The challenge for NIMA is to ensure that its data model and database designs do not constrain the incorporation of new data types.



The logic of using geo-referencing to break the tyranny of the intelligence stovepipes is clear. Thus, the burden of multi-INT integration falls on NIMA—NIMA is clearly the enterprise to organize such an endeavor by virtue of its deep geospatial knowledge and its capacious storage and networking capability (even if, as argued further below, it needs more technological capability to assume the job.

14.14 Precision and Persistence

Resolution, or ground sample distance (GSD), are watchwords in the imagery world. Information differs in how accurately it can be measured. Imagery (both EO and synthetic aperture radar), for instance, can be accurate to the sub-meter level—but not always: *e.g.*, MSI, HSI, and USI, for technical reasons, have successively less resolution, and correspondingly less geospatial precision. ELINT data are even less precise; so is most acoustic and seismic information. Most weather data are measured over kilometers.



Information also differs to the extent that accurate measurement is meaningful. Some phenomena are inherently fuzzy. Neither the habitat of a species, nor the turf of a gang, the catchment area of a shopping center, or the track of a storm can be usefully measured in meters. Assigning geospatial attributions to other phenomena is a stretch. Rumors, for instance, about impending governmental decisions in Ethiopia may be geospatially tagged to a specific office building in downtown Addis Ababa, but such tagging feels artificial or at least of questionable value since its source and impact may be geospatially distant from the office. Some information has no real geospatial content whatsoever: the characteristics of a weapons system, or reports on an impending religious schism.

It is pointless to give geospatial information more precision than is warranted. But every datum has to be anchored to some location in a geospatial database.

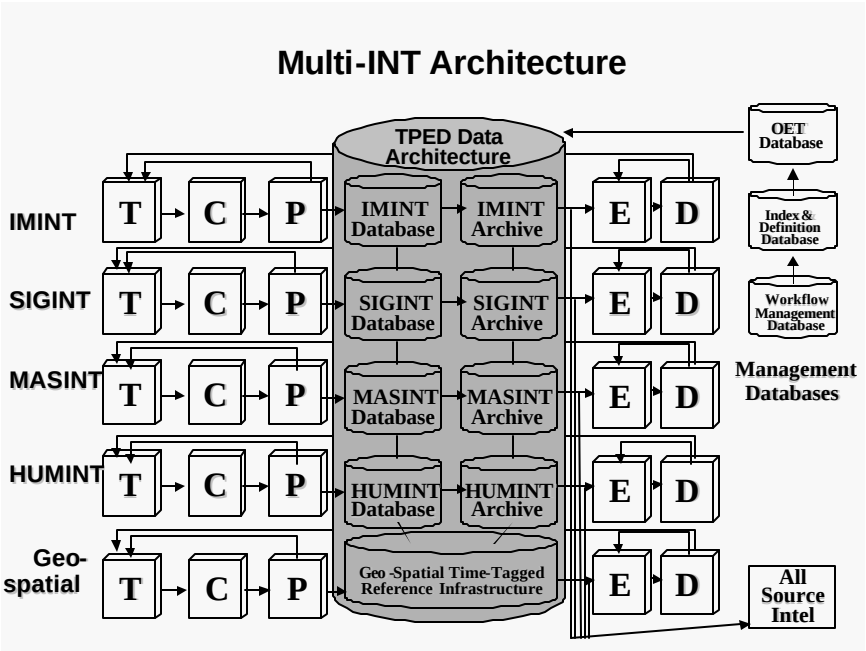
Persistence marks NIMA's products; evanescence marks the Common Operating Picture (COP). Yet, persistence is not a binary attribute. Take the accompanying figure. A mountain pass is forever. Successively, a paved road that traverses the pass, a gravel trail that leads off the road, an assembly point for mobile-missile launchers and finally, the Scud in flight are increasingly fleeting. Nevertheless, sensor-based data, for instance, of mobile objects acquires context, in large part, from a background of immobile objects. Accounting for trucks requires accounting for roads and passes, in a sense.

So where is the proper boundary between "NIMA's data" and that which makes up the Common Operating Picture (COP)? To what extent should NIMA's data model be built for eventual extension into the COP data model? Good questions, but no good answers, as yet.

14.15 Toward Multi-INT integration

The Commission believes that any architecture recommended by NIMA has to be able to evolve to a multi-INT architecture. Clear minds will separate this from the questions of who should implement and who should pay for the implementation.

NIMA should begin to engineer a broader architecture by which such INTs can be captured and presented in a coherent fashion. In its simplest form, other-INT data should be available as layers normalized to NIMA data. From whichever layer the user starts, he must be able to drill down to access the other information.



Multi-INT database(s), as they emerge, should take advantage of the inherent parallelism in TPED processes across the various INTs—as the accompanying figure

suggests, every INT, as a general proposition involves tasking, collection, processing, exploitation, and dissemination.

Still, it is important to note that the relationships among tasking, collection, and processing vary by INT. It is also important to note that this multi-INT architecture does not need to spring into being all at once. We can replace components as dollars and ideas permit, and invest in those areas that provide the highest payoff.

Serious thought is needed on how to manage a federation of databases, separately budgeted, with crosscutting management structures. Perhaps an intermediate but high-level interagency group could coordinate the overall data model, and the underlying technology standards, as well as sponsoring consulting and training. DIA's Joint Intelligence Virtual Architecture (JIVA) provides a model for consideration.

Finally—despite the Commission's enthusiasm—it is worth remembering that geo-referencing is not the only way to look at a mass of data.

14.16 Conclusions of the "Clean Sheet" Exercise

Building NIMA's architecture around a database that integrates maps and images and other relevant intelligence data, making this database independent of location and client, and permitting third-party annotation to it together constitutes the core recommendations for the information architecture.

Radical approaches like these are less risky than they sound. People have been doing data-centric architectures and databases for many decades, and GIS databases for at least two of them. The commercial industry is mature in all respects: workstations, databases, and GIS. Commercial capabilities already exist to do most of the imagery and geospatial manipulation that NIMA could want. NIMA is not being asked to approach this architectural requirement in a way and with a degree of effort that no one has ever done before; it is asked to apply familiar methods to its problems, which, if unique in scope, are not unique in form and content.

15. Recommendations

15.1 DOD and DCI Policy and Planning

15.1.1 Chairman, Joint Chiefs of Staff (C/JCS) should commission a study of the demands and constraints that military doctrine places on imagery intelligence and geospatial information. The study should be available for congressional review within 18 months.

With the increased reliance on Intelligence, Surveillance, and Reconnaissance (ISR) for military operations—witness the emphasis on information dominance canonized by *Joint Vision 2010/2020*—it is useful to reassess imagery and mapping support within the context of other military capabilities which it supports, and with which it competes for resources and management attention.

In some cases, the burden placed on NIMA, *inter alia*, for supporting evolving U.S. warfighting and peacekeeping doctrine is not fully appreciated. Moreover, the espoused doctrine of the individual services is not wholly synchronized with the *de facto* uses of imagery, and especially geospatial information, as they will manifest themselves over the next decade. The review of doctrine should aim to forecast better the future demands for these intelligence commodities, seek ways to better inform doctrine as to the likely availability and/or scarcity of new intelligence capabilities, and perhaps find ways to fine-tune doctrine so that it is less demanding of costly intelligence capabilities while achieving the same effect.

15.1.2 The Under Secretary for Acquisition, Technology, and Logistics (USD/AT&L) should include the cost of information as part of the total cost of ownership (TCO) of each new system; the programmed availability of that information should be the equivalent of a Key Performance Parameter (KPP). New, more emphatic guidelines should be promulgated to the Department of Defense, and available to Congress within one year.

Intelligence support, every bit as much as ammunition, fuel, spares, and training, is required to make today's military systems work. Too often in the past, a new weapons system was designed on the presumption that the information it needed to consume would appear, as if

by magic. Often, the Intelligence Community was able to work that magic. In today's fiscal reality, there is little or no discretionary resource left for such tricks. Such requirements, which can be forecast easily, must engender early debate about their dependence on an intelligence tail. Ignoring the intelligence bill—people as well as systems—at the outset precludes sound planning, programming, and budgeting, and forces invidious choices later on.

15.1.3 D/NIMA should provide positive mechanisms that inform every consumer as to the 'true cost' of NTM imagery in order to promote conservation of this scarce resource, as well as to support rational economic decisions about the use of commercial imagery.

Consumers—who levy requirements and generally make decisions that cause resources to be expended—must be turned into customers, with their appetites better matched to the nation's pocketbook, their expectations made more realistic. Among other things, this should help ensure that their decisions about use of commercial imagery are taken on an equal footing with those about use of national technical means. All-source analysts, weapons systems designers, operators—and, yes, even policymakers—all cause scarce intelligence resources to be expended on their behalf and should have a better appreciation of the opportunity cost of those resources at the time the effective decisions are made. The Community Management Staff, with C3I, shall perform the analysis as required to develop the cost basis, which will properly amortize all NTM development, acquisition, and operating costs.

15.2 Long-Term (Strategic) Versus Operational (Short-Term)–nee "National Tactical"

15.2.1 The DCI, operating through the ADCI/C in conjunction with the ADCI/AP, should provide a suitable mechanism for high-level, collaborative resolution of lingering imagery contentions.

The Commission found no conscious bias on the part of NIMA toward one community at the expense of another. Nevertheless, NIMA first of all needs to understand the ebb and flow of satisfying the competing demands and to sense when a serious imbalance looms; and

then needs to deal with changing perceptions of how it balances the needs of multiple customers across the national security community. NIMA must do a better job of establishing metrics and monitoring processes; the results of these should be made generally available. Notwithstanding, the perceived tension between the national community and the tactical community is a larger national security community problem, not the fault of NIMA, and the issue should be addressed as one of balancing long term (strategic) and operational (short-term) intelligence support to a wide range of customers.

The Commission believes that NIMA must be more attuned to impending imbalances; subsequently, communications between contending parties at a suitably high level can resolve disputes where positions among their respective subordinates have hardened. Even when the reconciliation disadvantages both parties, the example of high-level cooperation signals a spirit of cooperation that can keep an issue from festering among subordinates. The Commission was reminded repeatedly that the CINCs, too, have a national mission and they and their J2s do appreciate the necessity for investing intelligence in the long term even while subordinates closer to the daily fray sometimes do not feel they have that luxury.

15.3 Resources

15.3.1 ASD(C3I) and DDCI/CM should work with NIMA leadership to aggressively seek the sources and means—dollars, competent management, and skilled personnel—needed to make NIMA's mission whole and its infrastructure functional.

Admitting that resources are only part of the problem, the Commission observes that the Administration appears to have been reluctant to request from Congress those resources necessary to fully cure the ills that beset NIMA and to cover the acknowledged fiscal shortfalls. It is unclear why that might be, inasmuch as a failure to invest in imagery TPED will mean that the investment in FIA will not be fully realized. The fact that NIMA, as currently staffed, lacks the capability to execute those resources smartly does not mean the resources are not needed.

Budget forecasts have not been models of accuracy but rather the wishful consequence of an impoverished intelligence program, overall. The first step in repairing the problem is to

represent more accurately the true cost of TPED, the operations of NIMA as its mission has grown, and the cost to provide it with infrastructure that it failed to inherit from its predecessor organizations. A necessary concomitant is to establish metrics for determining that the money was well spent.

NIMA's analytic corps also requires relief from any future downsizing and in fact, a modest growth trajectory that will allow it to rebuild. As the corps gains back experience, the mentoring burden on those most experienced should lessen, which will, in turn, help erase the deficit of long-term research.

Finally, to anticipate a subsequent recommendation, centralized resources should be sought for offsetting the cost of commercial imagery.

15.3.2 The DCI and SECDEF should, at the earliest opportunity, provide additional SES/SIS billets for NIMA. Congress should act favorably on the request with similar alacrity.

NIMA requires an increasingly technical and skilled workforce and exceptional leaders to help it usher in the FIA area and fulfill the *Joint Vision* challenge of information superiority. NIMA is disadvantaged by the small number of SES/SIS billets it currently has—about half the overall government average, and many fewer, *per capita*, than other national intelligence agencies. The Commission considers it unlikely that it can find and retain the caliber of officer it needs and deserves unless the roster of SES/SIS positions can be augmented.

15.3.3 The Director of NIMA should request through the DCI, and Congress duly authorize and appropriate, an increment to the NIMA Program for advanced research and development (R&D); the position of Chief Technology Officer should be created and a top-notch individual found to encumber it.

The Commission is quite concerned about the level of research and development conducted by and on behalf of NIMA. Imagery and geospatial activities in the national security sector are only partially congruent with those of interest to the commercial information technology

sector. The Commission is convinced that inadequate R&D holds hostage the future success of TPED, USIGS, and of US information superiority.

NIMA's current budget for R&D is far from adequate, and the Director of NIMA is committed to trying to increase the NIMA R&D account. The Commission agrees that a larger percentage of the NIMA budget should be devoted to R&D, once the overall budget realistically is consonant with the mission—*i.e.*, *new* monies are required. To set a benchmark, the Commission notes that the NRO's Directorate of Advanced Science and Technology (AS&T) has a firm claim on 10-percent of the NRO's resources.

The notion of a Chief Technology Officer (CTO) who would be steward of the R&D program and technological confidant to the Director of NIMA appeals to the Commission.

15.4 Commercial Imagery

15.4.1 The Director of NIMA, in concert with the Director of NRO, should develop, within 120 days, a new commercial imagery strategy—i.e., prepare an integration plan for commercial imagery—consistent with current market conditions.

US policy, *a la* PDD-23, is to support US commercial space imaging ventures. Commercial imagery has obvious virtues: there are no security bars to sharing it with coalition partners, and/or Non-Governmental and Private Voluntary Organizations (NGOs and PVOs);[46] it can augment over-subscribed NTM assets and reduce contention for them; and ultimately use of commercial imagery can allow NTM to progress to esoteric sensing regimes of unique interest to the government.

Paradoxically, although US policy is to nurture US commercial space imaging, the existing NIMA/NRO Commercial Imagery Strategy has the characteristics of acting aggressively while in fact, performing poorly and passively with regard to commercial remote sensing products and services. While the leadership of those two organizations speak about a

[46] Commercial imagery is, however, subject to terms and conditions of contracts designed to preserve the intellectual property rights of the "owner"—*i.e.*, it must be bought and paid for to include the population with whom it would be shared. This "surcharge" for sharing reflects, more or less, lost opportunity to the vendor.

commercial imagery strategy, what they have in effect is a vision which has insufficient detail and implementation guidance to be an effective plan. Moreover, not only does the NRO, through NIMA, market a product that is technically competitive in some applications with commercial imagery (the latter lacks timeliness and volume), they "give it away" to customers who have to bear the brunt of the cost for commercial imagery, but pay naught for NTM imagery.

The integration plan should encompass how requirements expressed by users get translated into and allocated to either NTM or commercial imagery. The FIA-MIND is supposed to handle commercial (and airborne) as well as NTM imagery, but this is presently more promise than fact. Moreover, the several Intelligence Community "requirements systems" now under development have not yet taken up this challenge.

The Commission has hope that the move it urges toward a "data-centric" architecture will provide new insights into how requirements for imagery, imagery-derived intelligence, and geospatial information can be treated more similarly than different, independent of whether the source is USG or commercial, national or theater, exoatmospheric or endoatmospheric.

Among the elements of a revitalized Commercial Imagery Strategy: the Commission would include the following:

- ✓ **Understanding NIMA's real role in the market**. The government's roles as a customer and regulator of a commercial market will depend on what fraction NIMA is of total market share.
- ✓ **Stable funding**: funding instability has dealt a serious blow to the strategy's implementation to date. Stability mechanisms might include "fencing" funds in the Office of the Secretary of Defense, as the Commission elsewhere recommends.
- ✓ **Improved coordination role:** NIMA needs to improve its users' understanding of the equities and costs involved in the use of commercial remote sensing, as well as offer other value-added services. Independent acquisition of commercial imagery by DoD and IC users should not be considered threatening to NIMA's purpose.
- ✓ **Focus on acquisition of products and services:** NIMA and industry need an open dialogue about the variety of products and services that might create new value,

whether for NIMA or intelligence, writ large. Imagery purchases are an important part, but not the whole of the strategy.

- ✓ **Hands off, mostly:** Any emerging industry spawns winners and losers. NIMA should engage all serious industry players, purposely avoiding overreliance on any supplier. NIMA should advertise demand, and attract its satisfaction in as competitive a manner as possible. Use of foreign providers should be considered case by case.
- ✓ **Refining its business model for commercial imagery**: NIMA needs a better acquisition model for commercial imagery products and services based on understanding which products and services contribute most to its mission.

The person chosen to develop the NIMA commercial imagery strategy–and thereby stand as the advocate for commercial imagery within the national security community– must have the authority and responsibility needed to perform these roles. He or she must work to develop an understanding of how commercial and national imagery information systems interact with each other. This person must hold senior status within NIMA for the program to be effective.

15.4.2 The Office of the Secretary of Defense should establish a fund against which defense elements wishing to make direct use of commercial imagery can charge their purchase.

Forcing individual components to trade off beans and boots and bullets for commercial imagery when NTM imagery is perceived as a free good is impractical and does not further the overall commercial imagery strategy embodied in PDD-23. While it may be expeditious for NIMA to administer the fund, the Commission feels it imprudent to establish the fund in the NIMA Program or, indeed, in any program outside the immediate purview of the Office of the Secretary of Defense.

This commercial imagery fund should be the vehicle for end-users to buy both raw imagery and vendor's value-added offerings. The Commission estimates that, for the first year, $350 million seems about right; based on what the Commission expects to be a positive experience, that number should be expected to rise substantially throughout the FYDP.

Note that this suggested amount for end-user purchases is exclusive of traditional outsourcing of NIMA legacy products, *e.g.*, maps.

While the Commission views the DOD as the largest and most immediate problem, the DCI would be expected to adopt the same strategy if the DOD experience lives up to expectations.

15.5 Outsourcing

15.5.1 D/NIMA should commission an independent 180-day study to determine the maximum extent to which outsourcing could be extended, to include operation of all infrastructure, production of all legacy MC&G products, and much science-based imagery analysis. Results of the study should be provided to the DCI and the SECDEF within 30 days of completion, together with D/NIMA implementation(s).

The Commission believes that NIMA should adopt a "disruptive" business model based on a commercial strategy that always looks first to commercial vendors for source data, value-added products, information services, and infrastructure support.

The Commission rationale is threefold: (i) outsourcing operation (and, in some case, *ownership*) of infrastructure frees up resources, but especially management attention and, in the case of IT, scarce skills; (ii) purchase of commodity items from vendors is nearly always preferable to internal USG production; and (iii) NIMA cannot, itself, afford to maintain a broad base of scientific skills.

The study should, *inter alia*:

- ✓ include a core business function analysis, and consideration of any wartime exigencies that might contraindicate outsourcing;
- ✓ distinguish between simply outsourcing USG operations and buying end products and services from commercial vendors;

- ✓ review the capacity of those vendors to respond to NIMA's needs and suggest steps that may be needed to incentivize commercial suppliers to make capital investments in order to meet those needs;
- ✓ aggressively solicit input from commercial interests to ferret out nontraditional ways in which the USG could better structure its activities to foster outsourcing;
- ✓ identify areas in which NIMA's embrace of open standards and/or industry standards *vice* government standards would enhance the opportunities for outsourcing; and
- ✓ identify internal organizational, contractual, and cultural barriers that stand in the way of taking maximum advantage of outsourcing opportunities.

In the event that independent study shows, as the Commission expects, that there are major untapped opportunities for relying on commercial vendors, NIMA should petition for relief as needed from procedures dictated by OMB circular A-76, which allows "internal" components to "compete" against external sources.

15.6 Commercial Technology

15.6.1 D/NIMA should periodically review all "NIMA Standards" which, if divergent from industry, should be revised (or revalidated); and, move NIMA toward a level 3 organizational rating[47] for Software and System Acquisition.

The Commission believes that NIMA should be an acquiring organization, not a developing organization. To that end, NIMA should look to commercial technology developers and producers for solutions. D/NIMA should periodically review all development activities and consider their transition to acquisition.

The Commission observed a key distinction between military and intelligence organizations in this regard: within the Department of Defense, the Services are responsible for acquisition, while the agencies and CINCs are responsible for execution. Intelligence

[47] Based on the Software Engineering Institute's Capability Maturity Model.

agencies like NIMA and NSA are responsible for both intelligence production and the acquisition of systems designed to provide that intelligence[48].

15.7 TPED

15.7.1 DCI and SECDEF, with the full support of Congress, should form an "Extraordinary Program Office" (EPO) within 120 days in order to ensure the prompt and efficient acquisition of required TPED functionality and equipment.

NIMA does not have the organic capability to successfully acquire TPED, nor can it "get there from here," in time, using normal government practice. There is no help on the horizon because neither the NRO nor NSA has talent to spare.

NIMA leadership should seek redress from federal hiring restrictions to identify incentives to attract experienced personnel to meet its needs. NIMA leadership should also work with the imagery and GIS industries and academia to determine how to improve the industrial base to encourage more growth in these fields.

For the EPO proper, the special authorities of the DCI should be extended to create the "spaces" and the DCI and SECDEF should intercede personally with the private sector to get the "faces" to fill those spaces. Congress should codify the exceptional measures needed to set up and operate this Extraordinary Program Office (EPO).

It is anticipated that the EPO shall have a five-year lease on life, after which the Director of the EPO and D/NIMA will have arranged for a smooth transition of the required capabilities into NIMA proper.

The Director of NIMA shall ensure that the EPO is not bogged down in bureaucracy; streamlined, responsive contracting, security, and infrastructure services should be available to the Director of the EPO; the NRO model suggests itself, here.

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[48] The NRO is unique in the IC in that it is basically an acquisition organization.

Elements of an EPO

- ✓ Armed with the special authorities of the DCI as required;
- ✓ Staffed with world-class talent recruited through the good offices and persons of the DCI and SECDEF for at least a 3-5 year period.
- ✓ Endowed with world-class System Engineering and Information Technology capability;
- ✓ Provided with a dedicated, effective procurement and contracts capability;
- ✓ Free of domination by the aerospace industry;
- ✓ Using the most effective government/commercial programmatic tools;
- ✓ Simultaneously building an in-house SE/IT capability in NIMA for the longer haul;
- ✓ Overseeing TPED and R&D as related but separate programs, *i.e.* strong R&D that is immune from depredations by short-term TPED development needs;
- ✓ Following a sound business plan as the basis for its activities;
- ✓ Pursuing an architecture in line with the Strategic/Organization/Management considerations;
- ✓ Giving priority to sorting out consistent approaches to IEC and OET/WPF;
- ✓ Ensuring that TPED architecture is not proprietary but is based on open systems.
- ✓ Alert to the implication of new technologies associated with new collection techniques.

Within 120 days of appointment, the Director of the EPO shall prepare and coordinate a set of definitions that define the scope and content of TPED, FIA, USIGS, and multi-INT TPED, and prepare and coordinate with users in the US Imagery and Geospatial Community (IGC) a TPED CONOPS.

Within the same time frame, the Director of the EPO shall re-baseline TPED requirements and lay out the broad architectural (re)design, developing a strategy for transition from

legacy and current acquisition to the desired end-state. As part of the re-baseline effort, significant FIA shortfalls as identified by the JCS shall be considered. The Director of the EPO, consistent with these definitions, shall prepare an acquisition strategy.

The Director of the EPO shall include in the acquisition strategy appropriate use of commercial hardware and software. "Appropriate use" includes a strategy to migrate from legacy GOTS and customized code to COTS products.

The Director of the EPO should make an early determination as to the advisability of adopting as a design philosophy the data-centric/Web-centric architecture expounded on by the Commission as a part of its "clean sheet" exercise, and periodically commission a "technology road map."

The Director of the EPO shall ensure that the TPED architecture either explicitly provides for inclusion of multi-INT or is demonstrably extensible to accommodate multi-INT.

15.7.2 D/NIMA should produce a proposed revision to the current plan for IEC acquisition and deployment, to include new cost and schedule data, for aggressively replacing all IDEX terminals with a fully capable commercial alternative; DDCI/CM and ASD(C3I) shall find the means to allow D/NIMA to execute this accelerated plan.

The Commission has found what appear to be viable commercial solutions for IDEX replacement built around the very latest generation of high-end PCs, video boards, and standard operating systems. These solutions are viable today because of the high velocity of technology and were not foreseen when the IEC plan was put in place. This emphasizes the need for more adaptable acquisition plans that provide for midstream technology insertion and the Commission anticipates that the requested revised plan will incorporate this philosophy.

Behind the enthusiasm of the Commission to drive the price continually lower for capable soft-copy imagery exploitation is the desire, finally, to drive a stake in the heart of film-based exploitation and the purchase of yet more light tables. Although this worthy goal was

embraced by FIA, whose baseline included no provision for the production of film, that has already been modified when it was realized that the lack of affordable soft-copy exploitation capability meant that it would not be sufficiently widespread in time.

15.7.3 The SECDEF shall direct the ASD(C3I) and Chairman, JCS, to support the Director of NIMA and the Director of NRO in the preparation of a plan which clearly indicates the role and integration of airborne and commercial imagery into TPED and which integrates geospatial and imagery analysis.

The ASD(C3I) shared with the Commission a TPED vision that stipulates several phases. A later phase, as he described it, calls for the integration of airborne and commercial imagery. The Commission endorses this phased approach, but believes that the time scale should be compressed and the phases given more definition at the earliest opportunity.

15.7.4 Director, NIMA, should get out in front of any potential FIA upgrade; in particular, he should study the implications for TPED for the five FIA shortfalls identified by the JCS, each of which could have major TPED implications and none of which has been considered fully in the current architecture.

These collection-system options would, if added to FIA, constitute major contingent liabilities in the TPED Program. The Commission is concerned that, yet again, the Community may decide to add collection capability with neither an end-to-end design, nor any thought to the resource implications for the TPED segment(s).

15.8 Imagery Dissemination

15.8.1 ASD(C3I) should ensure that the communications architecture for imagery dissemination for Defense and its intersection with Intelligence subtends both the designs of NIMA (more generally, of the "national" systems) and the last tactical mile designed by the respective services and secure sufficient DOD funding for execution.

ASD(C3I) must acknowledge responsibility for end-to-end architecture, and take more forceful cognizance of the discontinuities that exist.

15.8.2 The ASD(C3I) shall coordinate the efforts of NIMA, DISA, and the NRO to ensure that both the communications links and acquisition strategy for communications systems are sufficient to support TPED in the FIA era. Director, DISA, shall certify his ability, within the current POM/IPOM, to satisfy NIMA communications needs for dissemination or report to the SECDEF and Congress on the reasons for his inability to do so.

Current DOD policy requires that the Defense Information Services Agency be the communications provider of choice. Moreover, DISA, in its role as architect for the Global Information Grid (GIG) holds NIMA's life's blood in its hands. There is some reason to question whether two architects, NIMA and DISA, should work separately on two sides of the same architectural coin—storage (library design), and communications. Based on past performance, there is also some reason to question whether DISA can fully slake the thirst of NIMA's users for delivery of their images.

15.9 Multi-INT TPED

15.9.1 The DDCI/CM and ASD(C3I) shall jointly determine the extent and pace of convergence toward a multi-INT TPED. Consistent with their findings, the Director of NSA and Director of NIMA, *inter alia*, shall conduct the necessary architecture study.

This, too, is consonant with the vision of a phased TPED, which the shared with the Commission. In his plan, a move toward multi-INT TPED is the last stage, and the Commission agrees both with the ordering and with the recognition that such major changes

take time; however, we stand at an historic moment when both imagery and SIGINT are redoing their respective "TPEDs." Missing the opportunity for converging them would be regrettable.

15.10 Management—Director of NIMA

15.10.1 The Director of NIMA should establish a Technical Advisory Board

NIMA has a paucity of high-tech alumni. It did not inherit from its forebears—principally NPIC and DMA—a seasoned technical cadre or a tradition of technical excellence beyond the respective operational areas of imagery analysis and map making. Consequently, the Director should seek technical insight and inspiration, and some perspiration, from outside advisors.

The Director of NIMA can be well served by an external panel of experts who, jointly and severally, can bring broad experience of both government and the private sector. Diversity should be the hallmark of the Board, with individuals who are intimate not only with the traditional contractor base, but also information technology endeavors of emerging importance to NIMA—colloquially, "dot.coms" and the like—as well as the science base on which exploitation of some future collection systems will depend.

15.10.2 The Secretary of Defense, with DCI endorsement and congressional support, should fix the nominal tour length for the Director of NIMA at five years.

The current tour length of the Director of NIMA, 2-3 years, is too short to solidify accomplishments, institutionalize solutions, and sustain the momentum for needed change; it allows the Director's intent to be frustrated by recidivists who wait out the change in leadership.

The Commission recommends that the DCI and SECDEF, with such help from Congress as may be needed, ensure that the Director of the National Imagery and Mapping Agency (D/NIMA) serve a nominal term of not less than five years, absent cause for dismissal,

subject to the personal needs of the individual. In the event that an active duty military officer serves as Director, the cognizant military service must commit to this length of tour and Congress should ameliorate any unique hardship that this entails upon the military service. The available alternative is civilian leadership with a military officer as deputy. Whatever the solution, the objective is to ensure better continuity and sustain the momentum.

15.10.3 D/NIMA, along with other intelligence organizations, should work with the JCS to establish the need for, and CONOPS for, advising US commanders of the likely adversary insights into US operations—the OPFOR J2 role—given the loss of US imagery exclusivity.

Information superiority, in its fullest form, is not only about one's own state of knowledge, but also that of the adversary. As we lose sources and methods generally, and imagery exclusivity particularly, it is vital for US commanders to know what the adversary knows, or could know. NIMA, using commercial imagery and tools that could be available to the adversary in accordance with adversary intelligence doctrine, will have to impute what the OPFOR state of knowledge can be.

15.10.4 D/NIMA should consider appointing an "Archive Manager" to maximize the value of the imagery archive, to be the advocate for archive use, and to create a "spec-deck" for tasking "to inventory" otherwise unused imaging capacity.

NIMA has made the imagery library a centerpiece of its architecture—a data warehouse, from which users can pull imagery and which also infers users' needs and pushes imagery or imagery advisories to them. With the passage of time, some of the warehoused material will appreciate in utility such as historical coverage of a now-current crises area, while the utility of other material such as repeated coverage of an inactive target will decline. That is, the inventory in the warehouse has a current asset value and the goal is to maximize this value.

The "Archive Manager" would be responsible for managing the archive, estimating its current and future value, and actively trying to increase that value. Beyond improving procedures and heightening awareness, it is anticipated that the manager would have (low priority, "background") tasking/purchasing authority to add imagery and imagery products

to the library "on speculation." The metric by which the manager is rated is the "return on investment"—the increase in inventory value generated by the opportunity cost of the input.

The mission of the Archive Manager might be managing both the operation of the warehouse and its investment value.

15.11 Culture and Convergence

15.11.1 Director of NIMA should regularize and extrapolate to the organization more broadly his experiments with teams consisting of both Imagery and GIS analysts to work specific, high-priority issues.

The Commissioners were heartened by a planned "experiment" to integrate Latin America imagery and geospatial analysts, *i.e.*, collocate those analysts who are Latin American specialists. NIMA should set explicit goals and performance metrics to determine whether collocation and integration works, how well it works, and how it may be extrapolated to other parts of NIMA. The plan for further integration should address the goal of melding into an overarching NIMA culture the separate cultures now extant, and should include training as an integral part of the reformation.

16. APPENDIX A: Terms Of Reference For The Independent Commission National Imagery And Mapping Agency (NIMA)

16.1 OBJECTIVE:

To establish terms of reference (TOR) and an operating plan to ensure that the legislatively-mandated NIMA Commission complies with the Congressional language.

16.2 BACKGROUND:

The Appropriations Conference Committee Classified Annex to the FY 2000 Department of Defense Appropriations Bill requires the establishment of an independent Commission to review NIMA. The appropriations conferees agreed to the House-initiated language and included directive language in the FY 2000 Conference Report for the National Imagery and Mapping Agency Program (NIMAP/NFIP) and the Defense Imagery and Mapping Agency Program (DIMAP/JMIP).

16.3 GENERAL:

- The Secretary of Defense (SecDef) and the Director of Central Intelligence (DCI) will appoint the members of the Commission. The SecDef and the DCI have delegated these responsibilities to Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD[C3I]) and Director of Central Intelligence for Community Management (DDCI/CM), respectively.

- The and DDCI/CM will select a Federally Funding Reserve and Development Contractor (FFRDC) to provide the Executive Secretary and Staff for the Commission.

- The DCI Administrative Staff will provide administrative, logistics, travel, security, and documents research support. The members of the Commission will be drawn from within and outside of the government.

- The commission shall include members with expertise in the following areas:

    - Large system development and acquisition;

    - Information technology;

    - Imagery technology;

    - Telecommunications technology; and
    - Organizational development
- The Commission shall include at least one member from the commercial imagery and geospatial industry and one member from an independent audit organization such as the General Accounting Office's Computer and Information Technology Assessment Office.

16.4 SPECIFIC COMMISSION TASKS:

- The Commission shall conduct a comprehensive review of NIMA's present organizational and management structures, current technology development and acquisition plans, business practices, and operational support services provided to the Defense Department and the Intelligence Community. The review should include, but not be limited to, the following issues and questions:
- The optimal future configuration of the management structure at NIMA;
- The most effective future course for NIMA's strategic technology development and acquisition programs;
- The prospect and the efficacy of greater use of commercial sources for imagery collection and exploitation, geospatial information, and storage and retrieval of data and information;
- The efficiency of NIMA business practices;
- An assessment of the NIMA workforce's acquisition experience and system integration experience, and
- The sufficiency of current requirements forecasts and cost estimates for USIGS to include an assessment of the adequacy of the budgetary resources devoted to USIGS over the current FYDP.
- The Commission will provide periodic briefings to the appropriations committees during the course of the Fiscal Year 2001 budget cycle with a final report to be delivered to the congressional defense and intelligence committee no later than 31 August 2000.

16.5 KEY EVENTS

The commission will execute a wide range of activities during its review of NIMA. Key events may include: agreement on Terms of Reference; information briefings by NIMA and other organizations as requested by Commission members; periodic updates to Congress;

site visits with national, theater and tactical customers; site visits to commercial vendors; site visits to NIMA operational locations.

16.6 ORGANIZATION/MANAGEMENT OF COMMISSION:

- Commission Members:
    - Peter Marino, **Chairman**
    - Kevin O'Connell, **Executive Secretary**
    - Nancy Bone
    - Jack Dangermond
    - Evan Hineman
    - Jim Hirsch
    - Robert King
    - C. Lawrence Meador
    - Keith Rhodes
    - Tom Weinstein
- Role of the Executive Secretariat

  The Executive Secretary will be responsible for developing the substantive themes for the Commission, record keeping, and the production of periodic briefings and the final report in accordance with commission direction. The Executive Secretary will ensure that all events required for the successful completion of review are accomplished by scheduling meetings with appropriate customers and adjacent agencies.

- NIMA's role:
    - NIMA will provide full access and availability to all data holdings and relevant documents as well as any further assistance as requested by the Chairman and the Commissioners.

17. APPENDIX B: List of Appearances and Interviews

The following is a list of individuals who appeared before the Commission or were interviewed by Commission Staff. Affiliations listed reflect the individual's primary association as of the time of the interview.

17.1 Office of the Director for Central Intelligence

CHARLES E. ALLEN
Assistant Director of Central Intelligence for Collection

BENNY L. BONK
Deputy Chief, Counter-terrorist Center

IRA CAMPBELL
Office of the Assistant Director of Central Intelligence for Collection

JENNIFER A. CARRANO
Director, Community Management Staff
Requirements, Plans, and Policy Office

CHARLES G. CLAPP
Community Management Staff

ANITA I. COHEN
Community Management Staff

STEPHEN COMER
Office of the Assistant Director of Central Intelligence for Collection

JOAN A. DEMPSEY
Deputy Director of Central Intelligence for Community Management

MARY ENGEBRETH
Community Management Staff

GARY FOSTER
Director of Studies, Collection Concepts Development Center

AMBASSADOR LYNN HANSEN
Collection Concepts Development Center

JOHN C. GANNON
Assistant Director of Central Intelligence for Analysis and Production

LAWRENCE K. GERSHWIN
National Intelligence Officer for Science & Technology

NORMAN K. GREEN
National Intelligence Council

SHISHU S. GUPTA
Community Management Staff

PAUL INGHOLT
Community Management Staff

MG JOHN R. LANDRY
National Intelligence Officer for Conventional Military Issues

BRAD A.LUCAS
Office of Deputy Director of Central Intelligence for Community Management

JOANNE ROBBINS
Special Assistant to the National Intelligence Officer for Science & Technology

KEVIN SCHEID

17.2 Community Management Staff

JOSEPH J. LANDINO
Community Management Staff

A. NORMAN SCHINDLER
Nonproliferation Center

JAMES M. SIMON, Jr.
Assistant Director of Central Intelligence for Administration

JAMES E. STEINER
Chief, Crime and Narcotics Center

GEORGE TENET
Director of Central Intelligence

ROBERT D. VICKERS
National Intelligence Officer for Warning

GEARY YOUNCE
Community Management Staff

17.3 Central Intelligence Agency

CHRISTOPHER J. COFFIN
Collection Requirements and Evaluation

RAY CONVERSE
Issue Manager

SYLVIA L. COPELAND
Deputy Chief, Office of Transnational Issues

ROBERT B. FOUNTAIN
Chief, Intelligence Policy Branch Collection Requirements and Evaluation

DOLORES D. GREENE
Deputy Director of the Program Office for Community Analysis

ANNE C. GRUNER
Deputy Chief, Arms Control Intelligence

WILLIAM C. HATCHETT
Issue Manager

RICH HEGMANN
Issue Manager

S. LESLIE IRELAND
Issue Manager

TERRYL R. KRON
Intelligence Officer, Arms Control

SCOTT F. LARGE
Group Director

PAMELA MCMASTER
Issue Manager

JERRY POHL
DI/OTI

RUSSELL E. SCHWEIKHARD
Chief, Office of Transnational Issues Collection Team

ROBERT M. SCOTT
Deputy Chief, Collection Requirements and Evaluation

CAROLYN STETTNER
Chief, Collection Requirements and Evaluation

PATTY VOLZ
Collection Requirements and Evaluation
Chief, Current Operation Team

GERALD E. WALSH
Collection Requirements and Evaluation

SCOTT WHITE
Deputy Director of Transnational Issues

JEFFREY K. WICHMAN
Issue Manager

DENNIS WILDER
Issue Manager

17.4 U.S. Congress

HONORABLE PORTER GOSS (R-Florida)
Chairman, HPSCI

KEN JOHNSON
Professional Staff Member, SSCI

SENATOR BOB KERREY (D-Nebraska)
Vice-Chair, SSCI
Chairman, NRO Commission

BETH A. LARSON
Democratic (Minority) Professional Staff Member, HPSCI

HONORABLE JERRY LEWIS (R-California)
House of Representatives

T. KIRK MCCONNELL
Democratic (Minority) Professional Staff Member, HPSCI

MICHAEL MEERMANS
Professional Staff Member, HPSCI

JOHN MILLIS
Staff Director, HPSCI

TIMOTHY SAMPLE
Deputy Staff Director, HPSCI

JOHN STOPHER
Professional Staff Member, HPSCI

GREG WALTERS
Staff Assistant, House SubCommittee on Defense Appropriations

17.5 Defense Intelligence Agency

MARION ALLEY
Intelligence Analysis and Production

WILLIAM B. HUNTINGTON
Chief, Defense Collection Group

REAR ADMIRAL LOWELL JACOBY
J2

NEAL O'LEARY
Director, Intelligence Analysis and Production

ART ZULKE
Chief, Transnational Warfare Group

17.6 Department of Defense

MARK BERKOWITZ
Director, Space Policy, Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence

TERRY HAGLE
CIO/A&I

THOMAS MACK
Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence

CHRIS MELLON
Deputy Assistant Secretary of Defense for Command, Control, Communications and Intelligence

MAJGEN HOWARD J. MITCHELL, USAF
Director
National Security Space Architect (NSSA)

ARTHUR MONEY
Assistant Secretary of Defense for Command, Control, Communications and Intelligence

CAPTAIN STEVEN D. MONSON, USN
Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence

GENERAL ERIC SHINSEKI
Chief of Staff, US Army

DAVID WHELAN
DARPA

MARK WILKINSON
DARPA

17.7 Federal Government

KAREN IRBY
US Geological Survey
Civil Applications Committee

WILLIAM B. WOOD
D/Office of the Geographer and Global Issues
State Department

CHUCK WOOLDRIDGE
Department of Commerce

17.8 National Imagery And Mapping Agency

CRAIG ACKERMAN
Geospatial Information and Services

WILLIAM ALLDER, JR
Deputy Director, Acquisition & Technology Directorate

KAREN ANDERSON
Geospatial Information and Services

MARK BLOOMFIELD
Geospatial Information and Services

BERTRAM BEAULIEU
Deputy Director, International & Policy Office

GREGORY BLACK
Acquisition & Technology Directorate

JIM BOYD
Director, Dissemination Services Office

MARCUS J. BOYLE
Deputy Director, Human Development

ROLAND BURDETT

DELL BOWMAN

DAVE BROADHURST
Director, NIMA College

THOMAS K. COGHLAN
Chief Financial Executive/Financial Management Directorate

ARMANDO COSTALES
Chairman, IRSCOM

BOB EDWARDS
Chief, Geodesy and Geophysics

JEFF EMLOMORE
Geospatial Information and Services

FRED FAITHFUL
Customer Support Planning & Analysis Directorate
Leadership Team

RAYMOND FARLEY
Geospatial Information and Services

JAMES FAHNESTOCK
Deputy Director, Research and Technology Office

TERRY FISCHER
Geospatial Information and Services

DOUG GATES
Senior NIMA Liaison
USSOCOM

MIKE GILBERT
Deputy, Plans and Program Division

JOE GOINES
Acting Assistant Deputy Director,
Geospatial Information Management Division

RUSSELL T. GUSTIN
Deputy Director, Information Services Directorate

GARY HACKER
Chief, Information Management Division

JAMES M. HARRIS
Deputy General Counsel, Intelligence

JOHN HELGERSON
Deputy Director, NIMA

JUDITH HODGE
Chief, Systems Integration Department

J. EDWIN HENSON
Acquisition & Technology Directorate

PAULA KANE
Deputy Comptroller, Financial Management Directorate

LOUIS KATZ
Division Chief, Functional Management Division

LTG JAMES KING
Director, NIMA

JOHN KRINGEN
Imagery Analyst

JIM KWOLEK
Director, National Technology Alliance

ROBERT LAURINE
Director, Research and Technology Office

BOBBY LENCZOWSKI
Deputy Director, Operations Directorate

LYNN MARTIN
Procurement and Contracts Office

KEITH MASBACK
Director's Initiatives Group

CHARLES A. MOORE
Media Generation Division

ED MORNSTON
Director's Initiatives Group

KAREN NORTHART
Director, Human Resources

EDWARD OBLOY
General Counsel

SUE PLEIMANN
Chief, Media Generation Division

SAMUEL E. POTEAT

CAROL RAUH
Chief, Aeronautical Navigation Department

BRYAN (DUSTY) RHOADES
Chief, Analysis Division
Plans and Analysis Office

PAULA ROBERTS
Chief of Staff

CHERYL RUSS

PATRICK SATTERFIELD
Chief, Safety and Navigation Department

WILLIAM STRAGAND

TIMOTHY SAMPLE

CAROL SLOPER
Central Imagery Tasking Office

ROBERT SMITH
Assistant Deputy Director, Information
Services Directorate

LAURA SNOW
Assistant Deputy Director, Human
Development

STEVE WALLACH
Assistant Deputy Director,
Data Generation Division

PATRICK WARFLE
Special Assistant - NRO

TIM WASHECHEK
Geospatial Information and Services

ROBERT A. WEBER
Director, International & Policy Office

SANDRA L. WEBSTER

SCOTT WHITE
NIMA/IA

TERRY WILCOX
Geospatial Information and Services

ROBERT ZITZ
Director's Initiatives Group

ROBERT UBBELHODE
Geospatial Information and Services

TERRY P. VERNIER
Director, Central Imagery Tasking Office

17.9 National Reconnaisance Office

COL EDWARD T. COPE
Deputy Director Systems Engineering Sector

KEITH HALL
Director

TIMOTHY HENLINE

GIL KLINGER
Director, Policy

BOB PATTISHALL
Former Director, Advanced Systems & Technology Directorate

JERRY WEIRICH

17.10 U.S. Commands

BRIGADIER GENERAL KEITH ALEXANDER
Director of Intelligence (CCJ2)
USCENTCOMM

LOUIS ANDRE
Special Assistant to the J2
2000 Joint Staff

BG RONALD L. BURGESS
Director of Intelligence
USSOUTHCOM

MAJOR BRIAN COLLINS, USMC
USSPACECOMM, J2 (ret.)

COL DIX
Director, Strategic Warning and Readiness Division,
Cheyenne Mountain Operations Complex
USSPACECOMM

LIEUTENANT COLONEL JIM DOCHERTY
Counterdrug Division
USSOUTHCOM

LTG MICHAEL L. DODSON, USA
Deputy Commander in Chief, Chief of Staff (CCDC)
USCENTOM

LIEUTENANT TIM DUGGAN
USSPACECOMM, J2XN

JOHN A. EVANS
Manager Commercial Satellite Augmentation,
Electronic Systems Center, US Air Force
MILSATCOM

MAJOR CRIS A. FUCCI
USFK, J2

BRIGADIER GENERAL NICHOLAS GRANT
J2, US Forces Korea
Deputy C-2
Combined Forces Command

CAPTAIN MICHAEL KUHN, USN
Director of Intelligence, J2
USSPACECOMM

COMMANDER LITTLETON
USSOCOM

BRIGADIER GENERAL JERRY MACABEE, USMC
Chief of Staff
USSOUTHCOM

ADMIRAL RICHARD W. MIES, USN
CINC

USSTRATCOM

MAJOR MOORE
USSPACECOMM, J36

MAJOR TIM NICHOLS
Director of Intelligence
Command Briefer
USCENTCOM

COMMANDER BJ O'KEEFE
Counterdrug Division
USSOUTHCOM

THOMAS P. PAGAN
Chief, Imagery Management Branch Joint
Intelligence Center
USSTRATCOM, J2

COLONEL JAMES PEUHEK
AF/XOS

COLONEL WILLIAM RUSSELL
USSOCOM
SOIO Center Briefings

CAPTAIN CHRIS SHANK
AF/XOS

MR. STACY STAAB
USSPACECOMM, J3

LIEUTENANT STEWART
USSPACECOMM, J5R

MR. MICHAEL TAVIK
USSPACECOMM

TOM TILLIOTSON
AF/XOS

CAPTAIN TRAVIS
USSPACECOMM

GENERAL ANTHONY ZINNI, USMC
CINC
USCENTCOMM

17.11 Industry

STEPHEN ANDERSON
TRW

SAM ARAKI
Lockheed Martin

JOHN T. BARAN
Vice President, Business Development &
Strategic Planning, BAE Systems

MARSHALL BANKER
President
BAE Systems

JOHN BURR
President
Resource 21

MARJORIE BYNUM
Vice President of Workforce Development
Information Technology Association of
America

JAMES CARR
Raytheon

TERRENCE CASTO
Harris Corporation

GENE COLABATISTTO
President
SPOT Image Corporation

JOHN R. COPPLE
Chairman and Chief Executive Officer
Space Imaging

JOHN CURLANDER
Vexcel Imaging Corporation

JACK DANGERMOND
President
ESRI

FRED DEMECH
TRW

JOSEPH K. DODD
Vice President, Government Programs
Orbimage

MARK EISNER
President
ForPower, Inc.

SUELLEN ESLINGER
The Aerospace Corporation

LARRY GEORGE
Lockheed Martin

LEWIS GRAHAM
Z/I Imaging

CHRIS HAAKON
Autometrics

GREG HAMELIN
Lockheed Martin

MARCUS HANSEN
Lockheed Martin

JEFF HARRIS
Lockheed Martin

JO HARRIS
Sun Microsystems Federal, Inc.

MARK HARRIS
Sun Microsystems Federal, Inc.

GENERAL RICHARD HEARNEY, USMC (Ret.), President
Business Executives for National Security

RAY HELMERING
Orbimage

AXEL HOFFMAN
HJW

DAVID HOLMES
Intergraph

STEVEN T. HUFF
Chairman
Sensor Systems, Inc.

LAWRIE JORDON
ERDAS

MIKE KEEBAUGH
Raytheon

JEFF KERRIDGE
Earthwatch

JAMES KOHLAAS
Lockheed Martin

MIKE KRAUS
Lockheed Martin

MARGARET LANGE
Autometrics

VIC LEONARD
Resource 21

DAVE LOUISE
HJW

MARK LOWENTHAL
Senior Principal Intelligence Programs
SRA International, Inc.

GUY MILLIKEN
ESRI

CHARLES MORRISON
Lockheed Martin

EDMUND NOWINSKI
Boeing

RICHARD O'LEAR
Lockheed Martin

KEN PETERS
Lockheed Martin

JAMES A. PROCTOR
Vice President & General Manager,
Government Communications Systems
Harris Corporation

BILL ROBINSON
Space Radar Corporation

MARK SAFRON
HJW

HERBERT SATTERLEE III
President and Chief Executive Officer
Earthwatch

WALTER SCOTT
Earthwatch

WILLIAM SHERNIT
BAE Systems

RONALD SMITH
Harris Corporation

ADMIRAL WILLIAM O. STUDEMAN,
USN (Ret.)
TRW

JAMES TATOIAN
Space Radar Corporation

MIKE THOMAS
VP Imagery and Geospatial Solutions
Lockheed Martin

REX TRACY
BAE Systems

TISH VAJTA-WILLIAMS
Vice-President, Strategic Business
Development
Space Imaging, Inc.

CRAIG WILSON
Boeing

JAMES WRIGHTSON
Boeing

17.12 OTHER

KEN COLUCCI
NRO Commission

PROFESSOR RANDALL DAVIS
Massachusetts Institute of Technology
Department of Electrical Engineering
& Computers,
Science Artificial Intelligence Laboratory

ARTHUR V. GRANT
NRO Commission

LEO HAZLEWOOD
Former Deputy Director of the
National Imagery and Mapping Agency

GEORGE HEILMEYER
Private Consultant

RICHARD HELMS
Former Director of Central Intelligence

LTG PATRICK M. HUGHES,
U.S. Army (Ret.)
President, PMH Enterprises LLC

MAJGEN KEN ISRAEL (Ret.)
Burdeshaw Associates, LTD.

ROBERT KOHLER
Former Director of the
Office of Development and Engineering

DR. CLIFF KOTTMAN
Chief Scientist
Open GIS Organization

LTG WILLIAM E. ODOM, USA (Ret.)
Hudson Institute

JOHN WHITE
Former Deputy Secretary of Defense

PROFESSOR SHIELA WIDNALL
Massachusetts Institute of Technology
Department of Aeronautics and Astronautics

The Commission also received written comments from:

JAMES MANCHISI
Vice President, Government Markets,
Commercial & Government Systems
Eastman Kodak

BRAN FERREN
Chairman & Chief Creative Officer
Applied Minds, Inc.

18. Glossary of Terms

ACTD	Advanced Concept Technology Demonstration: a defense program whose projects are developed to engineer emerging technologies and move them to the field.
AOR	Area of responsibility: the responsibility of a regional CINC.
API	Application portability interface: a piece of software, usually embedded in an operating system, which translates software code into a request for service.
Application	The use of capabilities (services and facilities) provided by an information system specific to the satisfaction of a set of user requirements. [P1003.0/D15]
Application Platform	The collection of hardware and software components that provide the services used by support and mission-specific software applications.
Application Portability Profile (APP)	The structure that integrates federal, national, international, and other specifications to provide the functionality necessary to accommodate the broad range of federal information technology requirements. [APP]
Application Program Interface (API)	(1) The interface, or set of functions, between the application software and the application platform. [APP] (2) The means by which an application designer enters and retrieves information.
Architectural Structure	Provides the conceptual foundation of the basic architectural design concepts, the layers of the technical architecture, the services provided at each layer, the relationships between the layers, and the rules for how the layers are interconnected.
Architecture	Architecture has various meanings depending upon its contextual usage. (1) The structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time. [IEEE STD 610.12] (2) Organizational structure of a system or component.[IEEE STD 610.12] The Department of Defense, in its own wisdom, defines three levels

	of architecture, *Operational Architecture, Technical Architecture,* and *Systems Architecture.*
Architecture Target	Depicts the configuration of the target open information system. [DoD 8020.1-M]
Architecture, Database	The logical view of the data models, data standards, and data structure. It includes a definition of the physical databases for the information system, their performance requirements, and their geographical distribution. [DoD 8020.1-M, Appendix J]
Architecture, Infrastructure	Identifies the top-level design of communications, processing, and operating system software. It describes the performance characteristics needed to meet database and application requirements. It provides a geographic distribution of components to locations. The service provider for these capabilities defines the infrastructure architecture. It includes processors, operating systems, service software, and standards profiles that include network diagrams showing communication links with bandwidth, processor locations, and capacities to include hardware builds versus schedule and costs. [DoD 8020.1-M, Appendix J, specifically paragraph 5(14)(c), Table J-2]
Architecture: Baseline and Target	Defined and are significant parts of the technical management planning information (previously the technical management plan [TMP]). [DoD 8020.1-M with Change 1]
Automated Information System (AIS)	Computer hardware, computer software, telecommunications, information technology, personnel, and other resources that collect, record, process, store, communicate, retrieve, and display information. An AIS can include computer software only, computer hardware only, or a combination of the above. [DoDD 8000.1]
Availability	The probability that system functional capabilities are ready for use by a user at any time, where all time is considered, including operations, repair, administration, and logistic time. Availability is further defined by system category for both routine and priority operations. [JOPES ROC]
Baseline	A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further

	development and that can be changed only through formal change control procedures or a type of procedure such as configuration management. [IEEE STD 610.12]
C^4ISR	Command, control, communications, computers, intelligence, surveillance, and reconnaissance: DoD's operational information systems considered together.
CAD	Computer-aided design.
CAT	Computer-aided topography: a medical imaging technique.
CIA	Central Intelligence Agency: the lead agency of the intelligence community responsible for analysis and HUMINT.
CIB	Controlled image base: NIMA's consolidated imagery of the world accurate to five meters.
CINC	Commander in Chief: a US general (or admiral) responsible for military operations over a specified area of operations.
CMO	Central MASINT Office: a DoD agency dealing with MASINT.
Communications Link	The cables, wires, or paths that the electrical, optical, or radio wave signals traverse. [TA]
Communications Network	A set of products, concepts, and services that enable the connection of computer systems for the purpose of transmitting data and other forms (*e.g.*, voice and video) between the systems.
Communications Node	A node that is either internal to the communications network (*e.g.*, routers, bridges, or repeaters) or located between the end device and the communications network to operate as a gateway. [TA]
Communications Services	A service of the Support Application entity of the Technical Reference Model (TRM) that provides the capability to compose, edit, send, receive, forward, and manage electronic and voice messages and real-time information exchange services in support of interpersonal conferencing. [TA]
Communications System	A set of assets (transmission media, switching nodes, interfaces, and control devices) that will establish linkage between users and devices.
Configuration Management	A discipline applying technical and administrative direction and surveillance to (a) identify and document the functional and physical

	characteristics of a configuration item, (b) control changes to those characteristics and (c) record and report changes to processing and implementation status. [MIL-STD 973]
Connectivity Service	A service area of the External Environment entity of the Technical Reference Model that provides end-to-end connectivity for communications through three transport levels (global, regional, and local). It provides general and applications-specific services to platform end devices. [TA]
COP	Common Operational Picture: a software application that shows where military units are stationed or military activity is taking place
pCOTS	Commercial-Off-the-Shelf (COTS)–Refers to an item of hardware or software produced by a commercial enterprise, available for general purchase, and sold in the marketplace to a variety of customers. Such items are at the unit level or higher. Such items must have been sold and delivered to government or commercial customers must have passed customer's acceptance testing, be operating under customer's control, and within the user environment. Further, such items must have meaningful reliability, maintainability, and logistics historical data. COTS has also been defined as "products that ship in volume."
DARPA	Defense Advanced Research Projects Agency: a two billion dollar defense agency in charge of high-risk R&D.
Data Dictionary	A specialized type of database containing metadata, which is managed by a data dictionary system; a repository of information describing the characteristics of data used to design, monitor, document, protect, and control data in information systems and databases; an application of data dictionary systems. [DoDD 8320.1]
Data Element	A basic unit of information having a meaning and that may have subcategories (data items) of distinct units and values. [DoDD 8320.1]
Data Interchange Service	A service of the Platform entity of the Technical Reference Model that provides specialized support for the interchange of data between applications on the same or different platforms. [TA]
Data Management Service	A service of the Platform entity of the Technical Reference Model

	that provides support for the management, storage, access, and manipulation of data in a database. [TA]
Database Utility Service	A Service of the Support Application Entity of the Technical Reference Model that provides the capability to retrieve, organize, and manipulate data extracted from a database. [TA]
DIA	Defense Intelligence Agency: a defense agency in charge of assessing foreign militaries.
Directory Service	A service of the External Environment entity of the Technical Reference Model that provides locator services that are restricted to finding the location of a service, location of data, or translation of a common name into a network specific address. It is analogous to telephone books and supports distributed directory implementations. [TA]
Distributed Database	(1) A database that is not stored in a central location but is dispersed over a network of interconnected computers. (2) A database under the overall control of a central database management system but whose storage devices are not all attached to the same processor. (3) A database that is physically located in two or more distinct locations. [FIPS PUB 11-3]
EIS	Enhanced Imagery System: a future but interim constellation of imaging satellites expected to precede FIA.
Enterprise	The highest level in an organization—includes all missions and functions. [TA]
Enterprise Model	A high level model of an organization's mission, function, and information architecture. The model consists of a function model and a data model.
EO	electro-optical: a family of imaging sensors that collect imagery in or just beyond the visible spectrum.
EPO	Extraordinary Program Office: a procurement office that enjoys great flexibility in manpower, budgeting, and reporting practices.
External Environment Interface (EEI)	The interface that supports information transfer between the application platform and the external environment. [APP]
FEMA	Federal Emergency Management Agency: a US agency responsible for disaster relief.

FFD	Feature Foundation Data: NIMA's 1:250000 series base maps
FIA	Future Imagery Architecture: the next complete constellation of imaging satellites distinguished by their greater numbers and larger pictures.
Function	Appropriate or assigned duties, responsibilities, missions, tasks, powers, or duties of an individual, office, or organization. A functional area is generally the responsibility of a PSA (*e.g.*, personnel) and can be composed of one or more functional activities (*e.g.*, recruiting), each of which consists of one or more functional processes (*e.g.*, interviews). [Joint Pub 1-02, DoDD 8000.1, and DoD 8020-1M]
Functional Activity Program Manager (FAPM)	FAPMs are designated by PSAs and are accountable for executing the functional management process. Supported by functional representatives from the DoD Components, FAPMs develop functional architectures and strategic plans, and establish the process, data, and information system baselines to support functional activities within the functional area. [DoD 8020.1-M Ch 1 B(2)]
Functional Architecture	The framework for developing applications and defining their interrelationships in support of an organization's information architecture. It identifies the major functions or processes an organization performs and their operational interrelationships. [DoD 5000.11-M]
Functional Area	A range of subject matter grouped under a single heading because of its similarity in use or genesis. [DoDD 8320.1]
Functional Data Administrator (FDA)	Office of the Secretary of Defense (OSD) PSAs exercise or designate functional data administrators to perform data administrator responsibilities to support execution of the functional management process, and to function within the scope of their overall assigned responsibilities. [DoDD 8320.1 and DoD 8020.1-M, Appendix A]
Functional Economic Analysis (FEA)	A structured proposal that serves as the principal part of a decision package for enterprise (individual, office, organization -see function) leadership. It includes an analysis of functional process needs or problems; proposed solutions, assumptions, and constraints;

	alternatives; life-cycle costs; benefits and/or cost analysis; and investment risk analysis. It is consistent with, and amplifies, existing DoD economic analysis policy. [DoDI 7041.3, DoDD 8000.1, and DoD 8020.1-M, Appendix H]
GA	Geospatial analyst: a professional capable of extracting meaning from geospatial data.
GIG	Global Information Grid: a DoD concept under which its information systems would be bound in a common network and have access to common information services.
GIS	Geospatial information system: a complete information system, which primarily holds cartographic, imagery, and related intelligence data.
GPS	Global Positioning System: a satellite constellation that permits receivers to locate themselves accurately to within a few meters
Hardware	(1) Physical equipment, as opposed to programs, procedures, rules, and associated documentation. (2) Contrast with software. [FIPS PUB 11-3]
HSI	Hyperspectral imaging: an imaging system that slices the visible (and nearby) spectrum into very small slices to bring out differences in reflectivity otherwise too subtle to see in a normal image.
HUMINT	Human intelligence (*e.g.*, informants, attaches, spies).
IA	Image analyst: a professional capable of extracting information from images using photo interpretation and other skills.
IMINT	Image intelligence.
Information	Any communication or representation of knowledge such as facts, data, or opinions, in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audiovisual forms. [OMB CIRC A-130]
Information Domain	A set of commonly and unambiguously labeled information objects with a common security policy that defines the protections to be afforded the objects by authorized users and information management systems. [DISSP]
Information Management (IM)	The creation, use, sharing, and disposition of information as a resource critical to the effective and efficient operation of functional activities. The structuring of functional processes to produce and

	control the use of data and information within functional activities, information systems, and computing and communications infrastructures. [DoDD 8000.1]
Information Resources Management (IRM)	The planning, budgeting, organizing, directing, training, promoting, controlling, and management activities associated with the burden (cost), collection, creation, use, and dissemination of information by Agencies and includes the management of information and related resources, such as Federal information processing (FIP) resources. [PL No 99-591, DoDD 8000.1.]
Information Technology (IT)	The technology included in hardware and software used for Government information, regardless of the technology involved, whether computers, communications, micro graphics, or others. [OMB Circular A-130 and DoDD 8000.1.]
Infrastructure	Infrastructure is used with different contextual meanings. Infrastructure most generally relates to and has a hardware orientation but note that it is frequently more comprehensive and includes software and communications. Collectively, the structure must meet the performance requirements of and capacity for data and application requirements. Again note that just citing standards for designing an architecture or infrastructure does not include functional and mission area requirements for performance. Performance requirement metrics must be an inherent part of an overall infrastructure to provide performance interoperability and compatibility. It identifies the top-level design of communications, processing, and operating system software. It describes the performance characteristics needed to meet database and application requirements. It provides a geographic distribution of components to locations. The service provider for these capabilities defines the infrastructure architecture. It includes processors, operating systems, service software, and standards profiles that include network diagrams showing communication links with bandwidth, processor locations, and capacities to include hardware builds versus schedule and costs. [DoD 8020.1-M]
INT	Intelligence: all forms of information collected on an adversary or other operationally relevant target.
Integration	Integration is the result of an effort that joins two or more similar

	products such as individual system elements, components, modules, processes, databases, or other entities, and produces a new product that functions, as a replacement for the two or more similar but less capable entities (products), in a framework or architecture in a seamless manner. Institute of Electrical and Electronic Engineers (IEEE) Standard (STD) 610.12 defines an "integration architecture" as a framework for combining software components, hardware components, or both into an overall system. [IEEE STD 610.12]
Interoperability	(1) The ability of two or more systems or components to exchange and use information. [IEEE STD 610.12]. (2) The ability of the systems, units, or forces to provide and receive services from other systems, units, or forces, and to use the services so interchanged to enable them to operate effectively together. The conditions achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. [Joint Pub 1-02, DoD/NATO] [JOPES ROC]
IR	Infrared
Legacy Environments	Legacy environments could be called legacy architectures or infrastructures and as a minimum consist of a hardware platform and an operating system. Legacy environments are identified for phase-out, upgrade, or replacement. All data and applications software that operate in a legacy environment must be categorized for phase-out, upgrade, or replacement.
Legacy Systems	Systems that are candidates for phase-out, upgrade, or replacement. Generally legacy systems are in this category because they do not comply with data standards or other standards. Legacy system workloads must be converted, transitioned, or phased out (eliminated). Such systems may or may not operate in a legacy environment.
Life Cycle	The period of time that begins when a system is conceived and ends when the system is no longer available for use. [IEEE STD 610.12] AIS life cycle is defined within the context of life-cycle management in various DoD publications. It generally refers to the usable system life.

Local Area Network (LAN)	A data network, located on a user's premises, within a limited geographic region. Communication within a local area network is not subject to external regulation; however, communication across the network boundary may be subject to some form of regulation. [FIPS PUB 11-3]
MASINT	Measurement and signatures intelligence: a catchall term for all sensor information that does not resolve itself into a recognizable image.
Migration Systems	An existing or a planned and approved AIS officially designated to support common processes for a functional activity applicable to use DoD-wide or DoD Component-wide. Systems in this category, though fully deployed and operational, have been determined to accommodate a continuing and foreseeable future requirement and have been identified for transitioning to a new environment or infrastructure. A migration system may need to transition to the standard technical environment and standard data definitions being established through the Defense IM Program, and must "migrate" toward that standard. In that process it must become compliant with the Reference Model and the Standards Profile. A system in this category may require detailed analysis that involves a total redesign, reprogramming, testing, and implementation because of a new environment and how the "users" have changed their work methods and processes. A detailed analysis may identify the difference between the "as is" and the "to be" system. [DoD 8020.1-M.]
MRI	Magnetic resonance imaging: a medical imaging technique.
MSI	Multi-spectral imaging: the color information in an EO image.
Multimedia Service	A service of the TRM that provides the capability to manipulate and manage information products consisting of text, graphics, images, video, and audio. [TA]
NIMA	National Imagery and Mapping Agency: a combat support and intelligence agency responsible for cartography as well as geospatial and image analysis.
NOAA	National Oceanographic and Atmospheric Administration: a civilian agency tasked with weather forecasting and conducting or supporting research on the air and oceans.

NRO	National Reconnaissance Office: a DoD agency responsible for designing and engineering reconnaissance and surveillance satellites.
NSA	National Security Agency: a DoD agency responsible for collecting signals intelligence.
NTM	Literally, "National technical means," a euphemism coined for treaty negotiations to avoid mentioning, *inter alia*, imagery reconnaissance satellites. It is often used, now, to distinguish imagery satellites flown by the USG from commercial imagery satellites.
OGC	Open GIS Consortium: a six hundred member consortium that develops and fosters geospatial information standards.
Open Specifications	Public specifications that are maintained by an open, public consensus process to accommodate new technologies over time and that are consistent with international standards. [P1003.0/D15]
Open System	A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered applications software: (a) to be ported with minimal changes across a wide range of systems, (b) to interoperate with other applications on local and remote systems, and (c) to interact with users in a style that facilitates user portability. [P1003.0/D15]
Open Systems Environment (OSE)	The comprehensive set of interfaces, services, and supporting formats, plus user aspects for interoperability or for portability of applications, data, or people, as specified by information technology standards and profiles. [P1003.0/D15]
Operating System Service	A core service of the Platform entity of the Technical Reference Model that is needed to operate and administer the application platform and provide an interface between the application software and the platform (*e.g.*, file management, input/output, print spoolers). [TA]
Operational Architecture	The *Operational Architecture* embodies the concept of operations (CONOPS). It identifies the operational relationships and information needs.
Platform	The entity of the Technical Reference Model that provides common processing and communication services that are provided by a combination of hardware and software and are required by users,

	mission area applications, and support applications. [TA]
Portability	(1) The ease with which a system or component can be transferred from one hardware or software environment to another. [IEEE STD 610.12] (2) A quality metric that can be used to measure the relative effort to transport the software for use in another environment or to convert software for use in another operating environment, hardware configuration, or software system environment. [IEEE TUTOR] (3) The ease with which a system, component, data, or user can be transferred from one hardware or software environment to another. [TA]
Process Model	Provides a framework for identifying, defining, and organizing the functional strategies, functional rules, and processes needed to manage and support the way an organization does or wants to do business—provides a graphical and textual framework for organizing the data and processes into manageable groups to facilitate their shared use and control throughout the organization. [DoD 5000.11-M]
Profile	A set of one or more base standards, and, where applicable, the identification of those classes, subsets, options, and parameters of those base standards, necessary for accomplishing a particular function. [P1003.0/D15]
Profiling	Selecting standards for a particular application. [P1003.0/D15]
Response Time	The ability to react to requests within established time criteria. To be operationally effective, the system must product the desired output in a timely manner based on system category for routine or priority operations. [JOPES ROC]
RFC	Request for comment: an Internet standard.
Scalability	The ability to use the same application software on many different classes of hardware/software platforms from personal computers to super computers (extends the portability concept). [USAICII] The capability to grow to accommodate increased work loads.
Seamless Interface	Ability of facilities to call one another or exchange data with one another in a direct manner. Integration of the user interface that allows a user to access one facility through another without any noticeable change in user interface conventions. [DSAC SYS IM]

SIPRNet	Secure Internet Protocol Router Network: DoD's Internet system for classified content.
SOAP	Simple Object Access Protocol: a proposed standard by which serialized XML-tagged material can be ingested into external programs.
SQL	Structured Query Language: a standard language used to formulate queries posed to databases.
SRTM	Shuttle Radar Topography Mission: a recent shuttle mission (November 1999), which measured global elevations to high levels of precision.
Stovepipe System	A system, often dedicated or proprietary, that operates independently of other systems. The stovepipe system often has unique, non-standard characteristics.
System	People, machines, and methods organized to accomplish a set of specific functions. [FIPS PUB 11-3]
System Management Service	A service of the Platform entity of the TRM that provides for the administration of the overall information system. These services include the management of information, processors, networks, configurations, accounting, and performance. [TA]
Systems Architecture	The *Systems Architecture* relates capabilities and characteristics to operational needs.
TCP/IP	Transmission Control Protocol/Internet Protocol: the key transport and addressing protocol for the Internet.
Technical Architecture	The *Technical Architecture* specifies a set of performance-based, primarily commercial, information process, transfer, content, format, and security standards. These standards specify the logical interfaces in command, control, and intelligence systems and the communications and computers (C4I) that directly support them. The technical architecture is a practical document, that identifies standards where products are available today. It is entirely consistent with and supportive of DoD's Specification and Standards Reform.
Technical Reference Model (TRM)	The document that identifies a target framework and profile of standards for the DoD computing and communications infrastructure. [TRM]

TEL	Truck, erector, and launcher: a vehicle from which missiles such as SCUDs are launched.
TIN	Triangulated irregular networks: a way to approximate an irregular surface by elevation points that are clustered in areas with inflection points or rough surfaces.
TPED	Tasking, processing, exploitation, and dissemination: a series of steps that, collectively, constitute NIMA's role in the process of imagery analysis (collection is outside NIMA's charter). TPED is made up of the functional allocation of ground segment tasks to support (imagery) collection/acquisition whether *via* satellite, aircraft, or commercial purchase.
UAV	Unmanned aerial vehicle: an airplane-like air breathing vehicle that is remotely flown and, to date, mostly used for taking pictures or video.
User	(1) Any person, organization, or functional unit that uses the services of an information processing system. (2) In a conceptual schema language, any person or any thing that may issue or receive commands and messages to or from the information system. [FIPS PUB 11-3]
User Interface Service	A service of the Platform entity of the Technical Reference Model that supports direct human-machine interaction by controlling the environment in which users interact with applications. [TA]
USGS	US Geological Service: the US agency responsible for land cartography and conducting or supporting research on the US landmass.
USI	Ultraspectral imagery: a more concentrated form of HIS.
USIGS	US Imagery and Geospatial Service: a NIMA umbrella term for its overall information system.
VMAP	Vector Map: a designation for a certain class of NIMA maps. VMAP.0 is a globally complete series of 1:1000000 maps.
VPF	Vector Product Format: the format by which the digital information of VMAP is encoded.
VPN	Virtual Private Network.
WAP	Wireless access protocol: a proposed standard by which Web pages can be received by and displayed upon small screen devices such as cell

	phones.
WGS	World Geodetic System: the standard by which points on earth are measured in real space (the current standard is WGS-84).
XQL	XML (extensible hypertext markup language) query language: a proposed language by which queries can be made against material marked up by the tags specified in the XML standard.